This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

APR 14 1920

UG
1
.U58

NUMBER 58

OCCASIONAL PAPERS
ENGINEER SCHOOL
UNITED STATES ARMY

PAMPHLET
ON
THE EVOLUTION OF THE ART OF FORTIFICATION

PREPARED UNDER THE PERSONAL DIRECTION OF
MAJOR GENERAL WILLIAM M. BLACK
CHIEF OF ENGINEERS, U. S. ARMY

1919

WASHINGTON
GOVERNMENT PRINTING OFFICE
1919

NUMBER 58
OCCASIONAL PAPERS
ENGINEER SCHOOL
UNITED STATES ARMY

PAMPHLET
ON

THE EVOLUTION OF THE ART OF FORTIFICATION

PREPARED UNDER THE PERSONAL DIRECTION OF
MAJOR GENERAL WILLIAM M. BLACK
CHIEF OF ENGINEERS, U. S. ARMY

1919

WASHINGTON
GOVERNMENT PRINTING OFFICE
1919

NUMBER 58
OCCASIONAL PAPERS
ENGINEER SCHOOL
UNITED STATES ARMY

PAMPHLET
ON

THE EVOLUTION OF THE ART OF FORTIFICATION

PREPARED UNDER THE PERSONAL DIRECTION OF
MAJOR GENERAL WILLIAM M. BLACK
CHIEF OF ENGINEERS, U. S. ARMY

1919

WASHINGTON
GOVERNMENT PRINTING OFFICE
1919

CHAPTER I.

INTRODUCTION.

This is a short treatise on the evolution of the art of fortification. Fortification is herein treated as one of the four main branches of the art of war, but in so doing it is not desired to place undue emphasis upon the art and science of the engineer. The operations of modern warfare have now assumed proportions so extensive and complex as to break down to a certain extent, the lines of specialized control which have been drawn for the past two hundred years. Engineer work must now be performed by all troops regardless of their primary functions. Nevertheless, the need for the technical specialist not only still exists, but has been shown by the recent war to be more important now than ever before.

The attempt is made to trace briefly herein the development of the principles which govern in this one branch of the art of war, and in so doing to show how the application of these principles has been modified from time to time, by the acquirement of a knowledge of the principles of strategy; by improvements in tactical organization, and in the mobility of troops; by developments in military weapons, both offensive and defensive; and by the application to the art of fortification of the advances in human knowledge.

As a history, this treatise is far from complete, because on several phases of the subject history throws but little light. Much, therefore, must be left to conjecture. This is true, not only of fortification, but also of the other branches of the art of war.

The curtain of history unrolls upon a well-developed civilization. Large towns and cities are already in existence and these are connected by well-developed roads and highways, with bridges where necessary. Commerce is already well established, both by land and sea. A succession of large empires has developed, flourished, and passed away. Wars have long been waged, some caused by desire for territorial aggrandizement and others by commercial rivalry. Battles have been fought by large and highly organized armies. The custom has become practically universal of surrounding all large cities by fortifications and the sieges of these towns and cities have played an important part in the conduct of wars.

For information as to occurrences antedating our earliest authentic history, we have but scanty knowledge, based partly upon tradition, partly upon archaeological explorations, and partly upon the recently acquired ability to read the inscriptions which the ancients left either in stone or baked clay.

Our finds in archaeological explorations are, of course, only of those articles which are composed of indestructible material, such as stone, clay, pottery, and some metals. All wood has long since decayed and though certain metals, such as gold and brass, still remain, all iron implements have, as a rule, long since turned to rust. We do, indeed, find stone arrowheads, spear points, and daggers. We find evidences of the construction around prehistoric cities of defensive works of almost unbelievable magnitude, of towers along the walls, of ditches in front of them, but of the means employed in active defense and of the artifices used in sieges we learn practically nothing.

The information which we get from the prehistoric inscriptions is exceedingly meager and fragmentary. The pictures, indeed, give us some indications of domestic and other scenes, and the textual inscriptions give us considerable information as to the main facts of history. But these inscriptions are after all not exceedingly numerous; they are scattered over considerable periods of time and, though they give us some general ideas as to the progress of human development, we can get from them almost no details as to the development of military art.

From the pictured inscriptions we get some idea of the kinds of weapons used, but we learn nothing of the tactical formations of the troops who used these weapons. From the text we learn of the rise and fall of dynasties with the occasional names of kings. We hear of successful wars of conquest and of the siege and captures of cities, but of the details of siege operations we learn almost nothing.

Not only is this lack of information true as to prehistoric times, but even for many years after the beginning of history the information which we obtain as to the details of military matters is exceedingly scant. Our earliest real history is the work of a Greek historian, Herodotus, written about the middle of the fifth century, B. C. The principal portion of his work relates to the Greco-Persian wars which took place in the earlier part of the same century. As a sort of introduction he gives us considerable information, based, however, largely upon tradition, as to the history of Greece and western Asia in the preceding century. Unfortunately, Herodotus was not a soldier, and his descriptions of military matters are exceedingly brief and the details of some of his battles are impossible.

After the time of Herodotus we have much more information as to the development of military matters, and some of this information in great detail, but unfortunately these histories are not complete, and while covering some matters with great care there are large gaps which can not be filled.

It is thus evident that the early history of the development of fortification, and in fact of any other branch of the science or art of war, is exceedingly difficult to compile, and much must be left to conjecture.

To be sure, in historic times civilized man has from time to time come in contact with less developed races and has left records as to the social and material conditions of such races. For instance, we know considerable concerning the conditions of the tribes of France when the Romans first came in contact with them, and similarly, concerning the conditions of the Germanic tribes. We are familiar with the condition of the American aborigines, during the period of colonization, as well as of the natives of Central Africa, of Australia, and of Tasmania, the latter probably the least developed human beings with whom civilized man has come in contact.

If we could assume that the development of man had gone on exactly similarly in all parts of the earth, we could fill many of the gaps in the history of the development of civilization, but we can not be sure of this. That the races along the shores of the Mediterranean from whom our civilization was derived went through exactly the same stages as have been noticed in other undeveloped countries, is, of course, most improbable, but that they went through somewhat similar steps is extremely probable. Based, therefore, upon the records of archaeological research, upon the readings of prehistoric inscriptions, and upon observation of man in less advanced stages of civilization we may conjecture with a fair degree of probability the course of development of the human race, both in peaceful affairs and in the application of its slowly increasing knowledge to matters relating to war.

In general the matter contained herein is based upon historical data, but as it may serve to illustrate well some of the basic principles of fortification, Chapter IV is devoted to a purely conjectural account of the probable early stages of the art of war and of the incidents of an early siege.

CHAPTER II.

RELATION OF FORTIFICATION TO THE ART OF WAR.

War may be defined as organized human strife.

Human strife is as ancient as human life itself. In fact in the very beginning, man's existence must have been one continual struggle against the forces of nature, against other animals, and against other human beings. As man's mastery over the animal world became assured and as his knowledge of the laws of nature increased, the struggle for existence became less acute, he became able to produce more than he consumed and soon learned the advantage of cooperating with his neighbors for their mutual benefit rather than of struggling against them. In other words, he learned the blessings of peace.

His very accumulations, however, soon became the cause of discord. His stores of the necessities of life aroused the cupidity of others; his luxuries excited their envy, and once again there was resort to force, on the one side to seize the goods of another and on the other to retain what he possessed. Human history has, therefore, been always an alternation of war and peace. At first, the periods of war exceeded those of peace, in later days the reverse has been true. Whether this tendency will continue and war will be abolished from the face of the earth remains for the future to decide.

THE ART OF WAR.

The compilation of the proved knowledge on any subject constitutes a science. The application of this knowledge to human affairs constitutes the corresponding art. Thus we have what we may call the science of war, the summation and compilation of all human knowledge relating to war, and the art of war, the practical application of this knowledge to the needs of mankind.

A complex subject such as war can usually be subdivided into subordinate sciences or arts. Each of these subordinate sciences or arts may be studied separately, but, since in application each must work in harmony with the others, their interrelationship must be kept constantly in view, both in study and in practice.

The art of war may be classified into the following principal branches:

1. *Strategy.*—The art of controlling and directing military activities so as to obtain the maximum results from successful operations and to suffer the least harm from unsuccessful operations.

2. *Tactics.*—The art of so disposing and utilizing available military elements as most surely to secure the local aims, as determined by strategic conditions.

3. *Logistics.*—The art of properly creating, training, transporting, and maintaining the forces of war.

4. *Fortification.*—The art of so altering the terrain as to increase its strategic, tactical, or logistic value.

In thus classifying the art of war into four main branches it is not possible, nor is it advisable, to determine their relative value. They are so closely related that the effect of each upon the others must always be considered. Local success is impossible without tactical efficiency, but the maximum effect of any local success can be obtained only through a proper application of the principles of strategy. The proper formation and distribution of military forces so as to secure either tactical or strategic success is possible only by a proper application of logistics. Finally, tactical and strategic aims and the maximum logistic efficiency can be obtained only when the most effective use is made of the principles of fortification, especially as exemplified by improvements in means of communication.

It has sometimes been said that fortification is merely tactics written upon the ground and that, therefore, the art of fortification should be considered as a branch of tactics. To be sure, a most extensive use of the art of fortification lies within the field of tactics where its use is subordinate to tactical needs, though it should, to a certain extent, control tactical dispositions. But the same principles of fortification, broadened in the scope of application, extend beyond the field of tactics and reappear in connection with strategy, subordinate to, though strongly influencing, the demands of strategy. Furthermore, since tactical and strategic dispositions are largely dependent on logistic conditions, the art of fortification, in so far as it affects logistics, is directly concerned with the problems of supply and maintenance. It is, therefore, evident that the art of fortification can not be considered as a branch either of tactics, strategy, or logistics, and that, of itself, it constitutes one of the main branches of the art of war.

It is hoped that this brief discussion of the art of war and its principal branches will make it clear that a detailed study of any one of the branches of the art of war should include a general study of all, and that no treatise, however comprehensive and detailed, of one of these branches can be considered especially complete or especially valuable in itself unless it includes frequent references to the other branches.

Many otherwise valuable works on the subject of fortification have been justly criticized for apparently making the study of fortification an end in itself. Not only this, but there has been a tendency in authors to divide the art of fortifications into different branches, and to specialize on one branch, overlooking the fact that the same general principles apply to all branches and that any one branch is but a special and to a certain extent local application of these general principles.

It has long since been recognized that the successful soldier must be a student. In order to employ his forces to the utmost advantage he must have a thorough understanding of the principles of tactics and strategy. He must understand the possibilities of logistics and fortification and must be thoroughly familiar with the latest applications of the mechanical arts to the matériel of war.

The tactical and strategic judgment can be truly developed only by actual experience in war, but in lieu of this much can be learned by a careful study of military history and by the imaginative application of the principles of tactics and strategy to map problems and to terrain exercises. A study of the possibilities of logistics and of the principles of fortification can be well carried on in times of peace. Their progress is to a great extent dependent upon developments in science and the mechanical arts, and in order to remain an expert, either in logistics or fortifications, the student must keep himself thoroughly informed as to the latest scientific or mechanical developments and the possibilities of their application to any of the branches of the art of war.

Fortunately, a study of military history shows that in all past wars success or failure has usually followed the observance or nonobservance of certain fundamental principles. The application of these principles, however, must vary with the conditions existing at the time, and the success of the leader will depend not only on his knowledge of the general principles but upon his ability so to apply them to existing conditions as to obtain the best results.

Unfortunately, a proper analysis of the history of past wars is extremely difficult, for, owing to an incomplete knowledge of all the attendant circumstances, the student is liable to make wrong deductions from the narrative of events as they have occurred. False theories are often promulgated and accepted for the time being. This is especially liable to occur immediately after a great war and before a sufficient time has elapsed to afford that general perspective upon which alone it is safe to base a judgment.

The military student should, therefore, be wary of accepting the somewhat hastily drawn conclusions based upon incomplete knowledge or study. In fact, it is believed that no greater lesson can be drawn from the experiences of the war just ended than that of faith in certain ruling principles of long standing which have been so thoroughly tried and proved as to be of practically universal acceptance. Forced by the emergency to consider important needs, and somewhat confused by the newest developments of military technique which have followed the general advance in human knowledge, the military leader in each new war must, nevertheless, have the courage to rely on those basic principles which have brought success to his predecessors in the past.

CHAPTER III.

THE ELEMENTS OF COMBAT THAT RELATE TO FORTIFICATION.

War is organized human combat. The essential principles of combat are the same, whether the struggle be between individuals, between families, tribes, nations, or leagues of nations. The following is a brief statement of the essential principles of combat in so far as they effect the art of fortification.

The object of all strife is the destruction or subjugation of the enemy. This requires offensive action, but at the same time it is necessary for a combatant to protect himself from the enemy's strokes. Consequently, defensive action also is required. A soldier must, therefore, be trained to defend himself as well as to attack the enemy, just as a fencer must learn to parry as well as to thrust.

In a pugilistic combat it is frequently advisable for one of the combatants to resort temporarily to defensive tactics alone, exciting or inciting the enemy to unusual offensive action in order that he may exhaust himself and thus become an easy prey later on. So, also, in war, it is frequently desirable temporarily to assume a defensive attitude in one part of the field of operations in order to concentrate forces for a stronger offensive action elsewhere, or to reserve strength throughout the entire field of operations for a later and stronger offensive action when the forces of the enemy shall have been somewhat weakened.

Similarly one of the parties, who, on account of being temporarily the weaker, is condemned for the time being to resort to defensive tactics, may find it desirable temporarily to assume the offensive in some localities in order to retard the approach of the enemy, break up his organization, or interfere with his preparations.

Consequently, the pure offensive and the pure defensive are seldom seen. We thus see that though for the time being and in any particular locality, all action must be either offensive or defensive, yet the offensive may be assumed for defensive reasons and the defensive for offensive reasons. In general the efforts of a conflicting force, especially if it be large, will at any one moment be divided between offensive in some localities and defensive in others.

History has shown that a successful offensive usually requires a greater force than a successful defensive, especially when the defensive side has the assistance of strong protective works. By this it is not meant that the offensive necessarily requires a larger force numerically, for superior weapons, superior organization, and more important still, superior discipline and morale, frequently more than make up for deficiency in numbers. Since it requires a smaller force for defensive action than for offensive, it is evident that it will frequently be to the advantage of the commander of a large force, even in an offensive campaign, to fortify portions of his line and to leave behind this portion only sufficient force to hold it, thus permitting him to concentrate a larger force for a strong offensive at a more desirable portion of the line.

Experience has shown clearly that decisive results can in the end be obtained by offensive action only. Defensive action can do no more than delay the final outcome. This would appear to be the fundamental law of combat. The reverse of this, however, is also true. The failure or inability of one of the combatants to take and press offensive action at the critical time may be the ultimately deciding factor in favor of the enemy. This has been shown by numerous occasions in history which will be noted from time to time.

It would appear to be another law of combat that in general the offensive action, which alone can bring decisive results, can come only through success in close fighting; that the side which is best prepared to push the close fighting will ultimately be successful; and that the arm of the service best fitted for close fighting is the most important arm of the service—all others being auxiliaries only.

In the days of the Greek phalanx and the Roman legion the infantry soldier was the one best prepared to do the close-in fighting. The infantry was, therefore, in those days the most important arm; the cavalry was only an auxiliary. In the early days of chivalry, the horseman being better fitted for close fighting than the infantry of the day, became the decisive arm. As the thickness and weight of armor carried by the mounted man increased, rendering the horseman and his horse unwieldy, the foot soldier again attained the superiority. This superiority of the infantry has been retained to the present time, as was well brought out in the recently ended war. The cavalry, the artillery, the engineers, and the air service are auxiliaries simply.

The navy, too, must be regarded merely as an auxiliary arm; for, essential as it may be that a maritime country possess a navy, history has so far failed to show any strongly contested war which has been brought to a decisive and final result other than by land action. Even in the Napoleonic wars, which are so often cited by the advocates of the superiority of sea power as proofs of their claims, it should be noted, that in spite of an absolute and almost undisputed control of the sea, England was unable to accomplish the overthrow of Napoleon until the infantry had destroyed his legions in Russia, driven them from Spain, and finally had overcome them on the fields of Belgium. To be sure it was control of sea-power which alone protected England from invasion. Had Napoleon been able to transport his armies across the channel he would probably have subjugated England, but, being unable to do so, he could not force the close action on land, by which alone he could have achieved final success.

The forces of war are in general composed of men, but regardless of the character of the organization of these forces, it is evident that they can exert their maximum destructive effect and oppose the greatest resistance in but one direction—the military front. It follows, therefore, that the effect of the combat of two opposing forces will depend to a great extent upon the direction in which the contact is made. The offense should, where possible, endeavor to strike the enemy in the flanks or in the rear; the defense should strive to so change front as to receive the attack in its front.

For maximum efficiency the forces of war must be given the utmost mobility; that is, speed and freedom of motion. Mobility is a matter of organization and transport. It, therefore, follows that combat is vitally concerned with the means of transporting the soldier, his weapons, and his supplies. Mobility is, therefore, dependent on problems of logistics. Logistics again is dependent largely upon the character of communications available.

In order to insure the most efficient results, unity of object and of action of all the elements of a force are essential. Such unity of action can be obtained only when all of the individuals concerned are trained and disciplined to perform properly their given functions, and are so organized as to permit the efforts of each to become effective in the action of the whole. The exigencies of combat have the strongest tendency to break down effective organization, and only the most thorough training and discipline can effectively combat this tendency.

In war, psychological values frequently outweigh the physical, and success usually goes to the side possessing the best morale. The dominating weakness of combat is that of fear, and the fear of an individual seems sometimes to be conducted to others and to run wavelike through the entire mass, producing a similar fear in all the individuals of the mass. It is necessary, therefore, not only to supplant fear in the bosom of each individual, but to check its spread to others when once it is developed.

In individual combat, fear is overcome by the emotions which inspire the combatant. In large masses, these emotions seldom exist unless specially fostered. In order, therefore, that an individual may become an efficient tool in the protection of the state, it is necessary to inspire in him emotions which will counteract the fear of death and leave him ready to perform his patriotic duties. Especially is it necessary that he should be given confidence in the assistance of his friends and should be made to realize that every other member of the organization can be relied upon to fulfill his part in the fray. It is evident, therefore, that the forces of war must be created and trained in such manner as to secure not only the maximum efficiency of tactical action, but also the advantages of high morale.

The morale of a force and, therefore, its resisting power, is much less when suddenly surprised than when a combat has been foreseen and prepared for. It is, therefore, essential that surprise should be guarded against, and for this reason all possible means should be used for securing as early information as possible as to the movements and intentions of the enemy.

THE ART OF FORTIFICATION.

The art of fortification was defined in the preceding chapter as the art of so altering the terrain as to increase its military value. The word terrain as here used is intended to include not only dry land, but also areas covered with water, in which obstacles may be placed, or even the air, which may be made unbreathable or impenetrable by sight.

The alteration of the terrain, that is, the application of the art of fortification, may affect military matters in several ways.

First, by facilitating the movement of troops and supplies; that is, by the construction of means of communication intended either to assist offensive action by enabling troops and supplies to be rapidly and conveniently moved to, or concentrated at favorable points; or to help defensive action by enabling forces to move rapidly from one place to another within a defensive work.

Second, by retarding or interfering with military movements; that is, by being so altered as to form obstacles to the movement of troops and supplies. This function is defensive only, and care must be taken lest the obstacles built act later as impediments to the movements of the defending forces.

Third, by the construction of works designed to give protection to personnel and matériel. This action is defensive only.

Fourth, by being so altered as to increase the offensive power of weapons, as in the construction of gun emplacements, batteries, etc., and the clearing of the field of fire. This action is offensive only.

In general, any piece of fortification work is designed to perform but one of the functions named; but in many cases, in addition to its main function, it will also assist in others. Thus while the walls which were customarily built around cities in acient times were intended primarily as obstacles against an assault, they also gave protection to the people behind them from the missiles thrown by the enemy, they provided roadways for the passage of troops from one part of the defense to another, and at the same time they provided excellent locations for mounting the defenders' heavy weapons.

In addition, these walls added much to the defensive morale. Thus by the sense of protection that they gave to the defenders, by the command and ease of action they provided for the defenders' weapons, and by the knowledge of their efficiency as an obstacle to surprise attack, they made the defenders feel that even though they might be outnumbered numerically, they were still, with the assistance of their walls and other defenses, more than equal to the enemy.

However, as is shown a few lines above, offensive action alone is decisive, and defensive action can but delay. For this reason, in order that the resistance to a siege may be effective, it is generally essential that there be an active resistance and that sorties be resorted to from time to time to interfere with the enemy's plans, to damage his works, and to wear him out by keeping him constantly on the alert.

It has been taught by some that the better designed the defensive works are, and the more protection they give to the defenders, the more difficult it is to persuade the defending forces to leave the proven security of their works for the untried dangers of a sortie in the open. It is believed that this is an error, for the higher the morale of a force the more ready it is for any kind of action, and the greater the protection given to the defenders by his defensive works and the more confidence he has in their impregnability the higher will be his morale.

CHAPTER IV.

MILITARY DEVELOPMENTS IN PREHISTORIC TIMES.

The appearance of mankind on the earth is lost in obscurity. We do not know when he appeared nor where; nor is it certain whether the different races of mankind had a common or merely similar ancestry.

In different parts of the earth, there were different races, each apparently springing from a single source, but this connection by blood was, for the time being, the only one that existed, for there was no racial organization. The first attempt at organization was apparently the family; later, groups of families bound together by common interests united to form tribes, and later still the different tribes united to form the beginnings of nations.

Geological research shows that the progress of prehistoric human life passed through successive stages of development, each marked by a distinctive advance in human knowledge. These successive stages have been given names based upon man's then existing ability to make use of the physical elements of the earth; such as the stone age, when implements and weapons were made of stone; the bronze age, when the softer metals came into use; the iron age, when a knowledge of working iron was acquired.

It is probable that this early progress was painfully slow and went on most irregularly in the various inhabited portions of the globe. In very favored sections, the progress was comparatively rapid, elsewhere slower, and, consequently, the designated periods at different places overlapped in actual time.

At a very early age, men lived in caves and wore clothes of skin. There were no domesticated plants or animals; implements and weapons were made of crude stone or bone.

Later, animals were tamed for domestic uses; agriculture was developed; and houses were contrived for shelter and defense. Clothing was woven into cloth; the manufacture of pottery was developed. The people drew together for the general defense of themselves and of their property. Later the city and its outlying agricultural zone became the typical unit of human organization.

In the beginning, communications were exceedingly simple, consisting of a mere trail through the woods. When necessary, goods were transported either by human carrier or, later, by pack animals. On water, rough open boats were used at first, propelled by paddles only, and later by oars and sails.

From the very earliest time, man had to fight for his very existence, but he soon learned to increase his powers of combat by the use of sticks and stones. Thus, an early distinction was drawn between the two classes of weapons—hand weapons and missile weapons. It is probable also, that at an earlier date, he learned the necessity of defending himself by taking shelter behind the trees or by the use of shields.

The hand weapon probably had its beginning as a stick broken from the tree or picked up from the ground. Later, it developed into the shaped club, and then into the stone hatchet or mace. Later, a stone knife or dagger seems to have been used, then probably the spear, the ax, and the sword.

The development of the missile weapon probably followed a more complicated course. There was first the stone thrown by hand and later by the leather sling, an appliance which continued in use for many long ages. Later there appeared the javelin, which was merely a spear, short enough and light enough to throw. The next great development in missile weapons was due to the discovery of the elastic property of timber and of twisted rope. The first weapon making use of this elastic power was probably the bow and arrow. Later, and just before the beginning of the historic period, there were developed more massive machines by which, based on mechanical principles, arrows and stones could be thrown for much greater distances than by the bows operated by hand.

In the early periods all able-bodied men were necessarily acquainted with the use of weapons. When necessary, a number of them would unite for concerted military action under the leadership of a chief chosen by themselves. These forces, however, were probably never large, and tactical organizations and movements were not attempted. Furthermore, as their necessities were few and they could usually live off the country, logistic problems were very simple indeed.

When two such forces came into contact, the action was probably characterized at first by the discharge of arrows. Later one or both of the parties would advance, and a hand-to-hand combat with spear or sword would ensue. The result of the action would depend upon superior skill, superior numbers, or superior morale. Finally, one party or the other would be defeated, and those of that side who could would attempt to flee.

As the country became more thickly settled and the tendency to gather into communities became more marked, man began to surround his communities or cities with defensive works for protection against marauding bands and against enemies.

Under the protection of these defenses, the remainder of the community could carry on its agriculture or other operations in comparative security.

In making these strongholds it was but natural to take advantage of the natural features of the ground. Commanding hills or knolls were considered valuable for this purpose, as were positions encircled wholly or in part by natural obstructions, such as watercourses or marshes. Availability of a sufficient water supply was an absolute essential.

Furthermore, the positions to be fortified had to be selected with reference to their accessibility for the hasty assembling of the tribe, so that in case of a sudden attack the different members of the tribe could quickly assemble within the stronghold, bringing with them supplies to last through a siege.

The earliest attempt at strengthening defensive positions probably consisted of the construction of timber stockades or fences, which would give considerable shelter to the defenders and act as an obstruction to an assaulting party. However, it must have been soon learned that timber structures might be burned or possibly torn down, and recourse was then had to a more permanent form of construction. Walls were built of earth or stone, sometimes surmounted by timber stockades. The earth for raising the walls, of course, had to be dug somewhere, and it was soon found that by taking this earth from immediately in front of the walls, the ditch thus dug would form a serious obstacle to the advance of the enemy. Considerably later, probably, it was found that turning in water so as to transform the ditch into a moat was still more effective.

For the protection of noncombatants from stones or missiles thrown by the enemy, it was not improbable that the use of underground caves or galleries was soon found to be desirable.

For the use of the defenders in getting into and from the fort, gates, of course, had to be left in the walls, and bridges had to be constructed over the ditches. These openings were, of course, made so that they could quickly be closed when necessary by heavy gates and the bridges over the ditches or moats were so constructed that they could easily be removed or destroyed.

Such a fort would necessarily form a serious obstacle to an invading enemy. The attackers could not easily destroy the rampart wall nor with the missile weapons of the day could they easily breach the stockade on top of the wall. In fact, their only practical method of attack would appear to have been an assault across the ditches and over the obstructing walls, subject throughout this approach to the fire of the defenders shooting from behind shelters.

At first sight it might have appeared that such a fort was impregnable, but history has shown that there is no fort that man can make that man can not take. The needs and the methods of attack are developed to meet all conditions which the defenders can oppose.

However, a fort of this character was of great strategic value. Its very existence was a clear indication of the determination of the owners to hold on to the position. No successful invasion of the land in war could be attempted unless the invaders were prepared to undertake the siege and capture of the fort, and unless an invader felt himself able to accomplish this, he would probably be deterred from attempting an invasion.

However, once thoroughly determined, the enemy would gather all his military forces together and advance to the conflict and lay siege to the fort.

It is to be assumed that the defenders—by spies or otherwise—would have obtained some notification of the purpose of the invaders, as the delay necessitated to the invaders in making proper preparation for so large an enterprise would naturally give the defenders time to take refuge in their stronghold and to gather there their families, goods, herds, and such food supplies as could be moved.

Upon approaching the stronghold, the invaders first select sites for their temporary camps, building around them such temporary defenses as they may consider necessary to protect them against possible sorties. While so doing, they study the fort to find possible points of weakness and, at the same time surround it so as to cut off all approaches and hold the defenders isolated within their works.

If it appears that an immediate and unprepared assault may bring success, they attempt it without delay. This initial effort serves at least to try the relative morale of the two forces. If the defenders are courageous and determined to resist, the result can be only the loss of many men to the attackers; but if the besiegers are also determined, this initial defeat will do no more than intensify their aggressive spirit.

In time the attackers analyze the defensive strength. They select what appear to be the weakest points of the fort and concentrate their strength against the most promising of these weak points, leaving merely an outpost line around the remainder of the fort. In general, the weakest points are those sections where the wall forms pronounced salients, the weakness of a salient being due to the comparatively narrow front and to the small volume of defensive fire which can be exerted from the salient upon the larger development of the invaders' line around the salient. The besiegers, therefore, concentrate their efforts against these weak points, and by superiority of fire attempt to drive the invaders from their works. Of course, a similar small-arms fire is attempted by the besiegers along the entire front so as to keep the defenders in ignorance as to the exact location and character of the attack, and the time when it is to be attempted.

In the meantime the besiegers are engaged in preparing fascines and brushwork for filling the ditch or in building small, portable bridges to span the ditch or moat. If the walls are sufficiently high, scaling ladders are also provided and grapples with which to pull down the stockade wall. Pitch and other inflammable materials are gathered together to be used in setting fire to wooden structures by means of flaming arrows.

All preparations being made, an attack is launched. The fire of arrows is redoubled, and, under cover of this fire, the attacking party rushes forward, fills up the ditch or spans the moat, crosses over and attempts to scale the wall; to tear down the stockade and, should any breaches be made, to force the way through them.

Meantime, however, the defense has not been idle. The work of the besiegers has been hindered by sorties and counterattacks, which sometimes have been successful in capturing material and supplies, and in thus delaying the progress of the siege. When the assault is started, the defenders concentrate their fire on the leading elements of the attackers as they try to cross the ditch or try to scale the walls. They tear down the scaling ladders, if possible, and throw off the grapples from the stockade. They thus force the attackers to pay heavily in lives for the opening of a breach. When the breach is made, the defenders concentrate their strength and attention upon the entering throng, striking it both in front and flank, and are able to crush the assault and to drive back the attackers demoralized from the walls, harassing them in their retreat. The defenders thus gain time to close the breach and repair the stockade. In this manner, and though possibly unable to attempt offensive sorties, the defenders making use to the fullest extent of the superior advantages of the defensive are still able to retain an aggressive spirit.

The cost in the assault is incurred chiefly in the passage of the ditch, and in the crowning of the wall, so that by the time the breach has been made, the heavy losses incurred have so reduced the morale of the besiegers that they are unequal to the task of meeting and overcoming the counter offensive to the breach.

To avoid these heavy losses in the approach, it is decided to attempt a surprise attack under cover of darkness. The besiegers, therefore, quietly make preparations for such a move. They gather again the material needed for filling the ditch, and in addition, quantities of fagots or brush, which they can set fire to and thus light up the foreground during the attack. Each man, of course, is instructed as to his particular place, and, at the proper time, the attack is launched, and, at the same moment, the illuminating fires are lighted.

The assault thus made is a failure. Confused in the darkness or by the peculiar glow of the illuminating fires, the attackers are unable to act with the close co-operation they had expected, and though able to make a new breach, it is not before the besiegers have been aroused and have had time to gather at the threatened spot. Defeated again, the attackers lose heavily and then retreat in haste. Still determined, however, to capture the place at any cost, the besiegers decide upon a new method of attack. Noticing that the principal advantage of the defenders lies in their ability to fire over stockades or through loopholes, the assailants decide to do likewise, and, under cover of darkness, they press forward and erect on the very outside crest of the ditch, stockades of their own, fitted with many loopholes and with benches for raising men sufficiently high to fire over the top of the stockade. Selected archers are stationed behind these shelters and thus protected try to make it prohibitive for the defenders to show themselves above the tops of their own stockades. In addition to this, attempts are made by burning arrows to set fire to the defenders stockades or any wooden structures which they may have within the fort. Under the protection of this outer stockade, the assaulting party once more, and for the last time, forms for the attack. They push across the ditch, carrying their grapples and scaling ladders with them, and make a new and more terrific attempt to take the works.

If the attack is sucessful, the defenders either surrender or are put to the sword. If not successful, the besiegers, disheartened by the losses and despairing of ultimate success, abandon the siege and start homeward.

The above description of the siege is, of course, arbitrarily drawn, but it serves to illustrate the principles upon which all siege operations are necessarily based.

CHAPTER V.

STATUS OF THE ART OF FORTIFICATION AT THE DAWN OF HISTORY.

As an introduction to a historical sketch of the development of the art of fortification, and of the other branches of the art of war, it would appear to be well to begin with a brief review of the status of the art of war and incidentally of other matters, at the earliest time of which we have reliable historic information. This period would appear to be about the latter half of the sixth century, B. C.

At this time the dominant power in the then civilized world was the empire of Persia, which included the whole of western Asia, Egypt in Africa, and the islands in the eastern end of the Mediterranean. The next most important power was Greece, divided into numerous city states scattered not only over the mainland of Greece and the neighboring islands, but likewise through the Greek colonies in southern Italy, Sicily, and the Mediterranean shore of France. Carthage in northern Africa was already a flourishing city, and about this time became independent of the control formerly exercised over it by the Phoenician cities on the eastern shore of the Mediterranean. Rome was still in its infancy and had barely begun in Italy the career of conquest which ultimately was to include practically the whole of the civilized world.

The Persian Empire was of quite rapid formation. It had started as a small kingdom in the northern part of Persia. Moving southward the Persians had come in contact with and had overcome the already decadent empire of Babylon and without difficulty had gathered into their empire all of Mesopotamia, Syria, Egypt, and the eastern part of Asia Minor. Proceeding westward on Asia Minor they had come in conflict with the Grecian cities on the Asiatic mainland, and, in general, without much difficulty, had succeeded in adding them also to the empire.

The older empires which had preceded Persia in this part of the world had been but loosely knit bundles of semi-independent states, hanging together merely by fear of the great king. The new rulers of Persia, however, introduced a more thorough system of centralized organization. They divided their entire empire into a number of satrapies, each under the control of a Persian satrap appointed by the king. Each of these satraps was given control of a small standing army to maintain peace and concord in his satrapy, while an additional large central force was under the control of the king.

As an aid to this highly centralized control, roads were built connecting Susa, the capital, with all the outlying satrapies, and a system of posts or messengers was establshed to bring quickly to the king information concerning the conditions of all parts of his empire.

This Persian Empire had succeeded to the rule of an already highly civilized section of the earth. It contained many large cities, already hundreds of years old. These cities were surrounded for defensive purposes by large walls of great size fitted with towers at intervals, and sometimes by ditches, either dry or wet, though the ditch had not yet become the ever-present accompaniment of the wall that we find later. The area within these walls included not only the cities proper but in most cases considerable areas of arable land, upon the produce of which, in addition to the stores kept in these cities, the population could, in case of a siege, exist for a long period. Under the protection of these walls and of the small guards kept constantly on duty the citizens could carry on in safety their various occupations, agricultural, industrial, commercial, etc. The character of construction of these defensive walls varied according to circumstances. Where rock was available this was used, but in many places, and especially in Mesopotamia where rock was scarce, the walls were usually built of brick.

Commerce had long been in existence and was of great value. On land it was carried on by caravans or pack animals and on the sea by vessels propelled, as a rule, by sails but fitted for oars for use in emergency. So bold were the navigators that not only had they traversed the whole of the Mediterranean but they had sailed boldly out into the Atlantic, and had proceeded many miles southward along the coast of Africa, and as far north as the British Isles.

The principal centers of this water-borne commerce were the Phœnician cities on the eastern shores of the Mediterranean. Of these the most prominent was Tyre. This city was very old and had in the preceding century or so successfully withstood several sieges, owing its safety to being built on a large island, separated from the mainland by a body of water several hundred yards wide at its narrowest point. Threatened, however, with the commercial growth of the neighboring cities, it had, a few decades before, capitulated on very favorable terms to the Assyrian monarchy and similar arrangements had been agreed upon with the Persian rulers, who had been most anxious to obtain the influence of Tyre as a means of controlling the commerce of the Mediterranean.

However, the commercial supremacy of the Phœnicians was not unchallenged, as several of the Greek cities also had already begun to carry on commerce with other Greek cities on the mainland and on the various islands, and with the Greek colonies in the west.

This large commercial use of shipping had naturally suggested the organization of fighting ships. The organization of naval fleets had been started but was still in its infancy, although already naval battles had played their part in warfare.

Weapons both of iron and brass were in use. The most powerful infantry weapon was the long pike which, among the Greeks at least, sometimes attained a length of twenty-four feet. Considerably shorter than this was the spear which might be used either for thrusting or for casting, and the javelin intended for casting only. There were swords of various lengths and shapes depending to a certain extent upon the character of the fighting expected and upon individual tastes. The lighter armed troops used bows and arrows and sometimes slings. As a rule the bows were small, but crossbows had been introduced to some extent amongst certain of the Persian forces.

In general, the heavier armed soldiers wore some form of armor—helmets on the head, shields, carried as a rule on the left arm, and protecting metals for their thighs and legs.

The Persian Army was well organized and trained. The flower of this army was the Persian Cavalry recruited at this time entirely from native Persians, skilled in horsemanship and inured to hardships. In the open planes of western Asia this cavalry had been found to be especially useful and as a rule, up to this time, had been able to overcome any infantry with which it had come in conflict. They were armed with long lances for the charge and with swords for the mêlée.

The native Persian bowman was also a most important element of the Persian Army and formed the main body of infantry. Although some branches of the infantry carried pikes for use in the charge, the main infantry reliance seems to have been upon the efficiency of the bowman, and upon his ability to so demoralize the foe as to make them an easy prey for the cavalry charge.

Among the Greeks the most important part of the army was the infantry, composed principally of the heavily armed "Hoplites," who fought in large concentrated masses known as phalanxes, 16 ranks deep and as many as 300 files wide. They carried long pikes, those of the front ranks, however, being slightly shorter than those of the rear ranks, so that seen from the front they presented an impassable mass of spear points. In order to preserve the unity of the phalanx, upon which its efficiency depended, it was necessary that they maneuver comparatively slowly. Upon occasion, the soldiers near the flanks could, of course, make front to either flank and those in the rear could face about, but this was only possible when the entire phalanx was at rest. As a whole, the phalanx was an unwieldy body. They depended for their successes upon the charge and mass action, and as they were comparatively weak in the flank, it was necessary that their flanks be guarded by cavalry or lighter armed infantry troops.

A few of the states in northern Greece maintained bodies of efficient cavalry, but as a rule the Greek armies depended upon their infantry and the cavalry was in use only for protecting the flanks or for scouting.

Of the battle tactics of the day we know comparatively little. It would appear, however, that the opposing forces would form up facing each other in their respective orders of battle, the heavy armed troops in the center and the lighter armed troops on the flanks. At the proper time one side or the other would advance and the outcome would depend to a great extent upon the result of this charge. Of maneuvering on the battlefield after the battle lines had once been formed, we hear practically nothing, although there were occasions, when certain portions of one or both forces which had been held out as reserves were thrown into the most threatened portions of the line.

In most of the campaigns, sieges played a most important part. With their deep ditches and large and massive walls fitted with towers at intervals, the cities as a rule were difficult to capture and the sieges required much time. The first operation in a siege usually was to surround the place, cutting off all communication with the outside and throwing the besieged upon their own resources, the supplies which they had already placed in storage or upon such food as they could grow on the arable land within the walls.

Of the siegecraft of the time but little is known, but it it assumed to have been not greatly different from that which was in use a century or so later. War engines worked by mechanical power were already in use and had been in use for several centuries. By these means, stones, large arrows, beams of wood, etc., could be thrown into the cities or against the walls, but it is probable that the machines were quite crude and ineffective. The battering ram had long been used for battering down parts of the walls or for smashing in the gates, and scaling ladders were brought up when an assault was to be attempted.

Machines for throwing stones from the walls against the enemy and his war engines were, of course, sometimes used by the besieged, but it would appear that in general and except for the arrows, stones, and other missiles thrown from the walls against the attackers, the defenders trusted rather to the size and strength of their walls and tried little in the way of an active defense.

Occasionally we hear of quite unusual expedients having been used in sieges. Thus it is said that the Persians captured the city of Babylon by diverting to a new course the Euphrates River and then marching in over the old river bottom thus left bare.

We hear of many cities being captured and also of numbers of sieges that ended unsuccessfully. We hear as a rule, however, of a greater number of sieges which ended by negotiation between the besieged and besiegers. In fact, many resorts to such agreements to obtain possession of a city were made by the Persian monarchs, for it was evidently to their interest that the country over which they hoped to rule and the cities which they expected to form part of their empire, should be taken possession of with as little damage as possible. Consequently they were quite prone to offer quite advantageous terms to the besieged cities. This was especially true in their negotiations with Tyre and some of the other important commercial cities along the shores of the Mediterranean, for it was evidently to the great advantage of the Persian Kingdom to obtain control of these commercial cities and of the ships and sailors pertaining to this commerce, while interfering as little as possible with the commerce itself.

CHAPTER VI.

PROGRESS IN THE ART OF FORTIFICATION IN ANCIENT TIMES.

In this chapter there will be described briefly the progress made in the art of fortification, and incidentally in the other branches of the art of war, during the period of about a thousand years beginning at the time described in the preceding chapter and continuing to about the break-up of the western Roman Empire due to the inroads of the Germanic tribes.

The general progress of the world's history during this period is so well known as hardly to need mention here, the conflict between the Persians and Greeks beginning with the unsuccessful invasion of Greece by the Persians, and ending a century and a half later, with the invasion and conquest of the Persian Empire by the unified Greeks under Alexander the Great; the rapid break-up of Alexander's empire after his death, into several smaller empires ruled by Grecian dynasties; the duel in the west between the growing power of Rome and the already established empire of Carthage resulting in the complete destruction of the latter; the gradual extension of the Roman Empire until it included all western Asia, all Africa north of the Sahara, and the southern half of Europe; the centuries of the so-called Roman peace during which time, except for frontier fighting, the Roman world lived in quietude; the gradual transfer of the political center of the empire from Rome to Constantinople; the division of the Roman Empire into two parts, and the ultimate dissolution of the western half.

During this thousand years there were no great inventions or mechanical developments to make any sudden changes in the art of war or any of its branches, and such changes as did occur were evolutionary rather than revolutionary.

In tactics the principal change was a great improvement in the mobility and maneuvering ability of the infantry even in the face of the enemy. As was stated in the preceding chapter, the older Grecian phalanx, the basis of the infantry arm of the day, was an unwieldy body. It was made more mobile by the Theban general Epaminondas and still more so by Alexander the Great. The greatest change, however, was made by the Romans who substituted a short sword for the long and heavy pike, and more than made up for the loss of the longer weapon by the superior discipline and training given to the legionary soldiers. Their mobility, discipline, and unity of action enabled them to overcome the improved Greek phalanx and all other enemies with whom they came in contact. Especially were they trained in siegecraft as will be hereinafter noted.

A knowledge of the general principles of strategy was acquired by a succession of skilled military leaders who evidently effectively grasped the principle of striking directly at the heart of the enemy and in so conducting simultaneous operations in many places as to obtain the maximum results from their tactical successes.

In military policy there was a gradual change in the organization of the armies from the citizen militia, of which the early Greek and Roman armies were composed, to the professional soldier, and eventually to the hire of mercenaries. During the days of the greatest extension of the Roman Empire, it was found desirable to attach the soldiers recruited in one part of the empire to the legions stationed in another, so that there might be no undue sympathy between the garrisons and the inhabitants of the vicinity. Later, as the outlying Germanic tribes began their inroads, the German warriors were recruited for the legions, and still later it became necessary to hire some of these tribes to fight with their tribal organization and to try to hold back other tribes. Finally this policy in turn proved ineffectual and the Western Empire fell before these invading tribes. The Eastern Empire still continued its existence for another ten centuries, depending however for its defense largely upon professional or mercenary soldiers.

As an accompaniment to the steady growth of water-borne commerce, which occurred especially during the middle of this period, there was an increase in the importance of naval fleets. Not only was the commerce in what may be called luxuries, but in many cases it included the very necessities of life. Thus, by about the middle of the period, a large part of central Italy had become dependent for a sufficient food supply upon foodstuffs brought in by vessels. Upon the protection of these food vessels from pirates or the enemy's ships depended therefore the very life of the inhabitants of Rome and the vicinity. Naval vessels intended primarily for the protection of commerce, and some of the commercial vessels which could be altered into war vessels, would in war naturally be used in aggressive action against the enemy's fleet. We thus find numerous wars and campaigns in which naval actions were important if not the ultimately decisive elements.

IMPROVEMENTS IN FORTIFICATION.

During this period, as in the other branches of the art of war, there was a considerable though gradual advance in all branches of the art of fortification.

Communications.

The system of communications started by the Persians was gradually improved by Alexander and his Grecian successors. In the west the value of improved roads in keeping a large empire in close communication with its capital was thoroughly understood by the Romans who constructed throughout practically their whole empire systems of paved roads so well designed and built that portions of them are still serviceable to-day, after the lapse of nearly 2,000 years. These roads, of course, radiated from Rome to the principal cities of Italy and the outlying provinces, and from these principal cities to the smaller cities and outlying frontiers.

That the Romans well understood the offensive value of communications, which form one of the classes of fortification construction, is shown by the fact that not only did they construct a permanent system of highways, connecting the capital with the outlying portion of the empire, but in all of their military operations they found it well to construct and improve communications. It was by the use of these permanent and temporary communications that they found it possible to move large armies over their vast empire and to concentrate these armies at desired locations with comparative speed.

As a good example of a temporary military communication, we have the bridge constructed by Caesar across the Rhine near the present city of Coblenz. After having pacified the Gallic and Germanic tribes to the west of the Rhine, he was attacked by a number of Germanic tribes from east of the Rhine who had crossed the river for the purpose. These he defeated and drove back over the river, but in order to insure the future peace of the country, he thought it necessary to cross the river and teach the enemy a lesson by devastating their own land. Hesitating to do this by boats, lest his army should be attacked in detail while crossing the river, he thought it necessary to build a bridge, a detailed description of which he gives in the fourth book of his Commentaries. (A sketch of the bridge prepared from Caesar's own description is shown on Pl. I.) It will be noted that the character of construction used by him is extremely similar to that in use at the present day.

Another famous example of an early bridge constructed in military operations is that built by the Persian King, Xerxes, across the Hellespont in his advance on Greece about 480 B. C. This bridge was constructed of boats and is described, though somewhat badly, in the history of Herodotus.

PLATE I

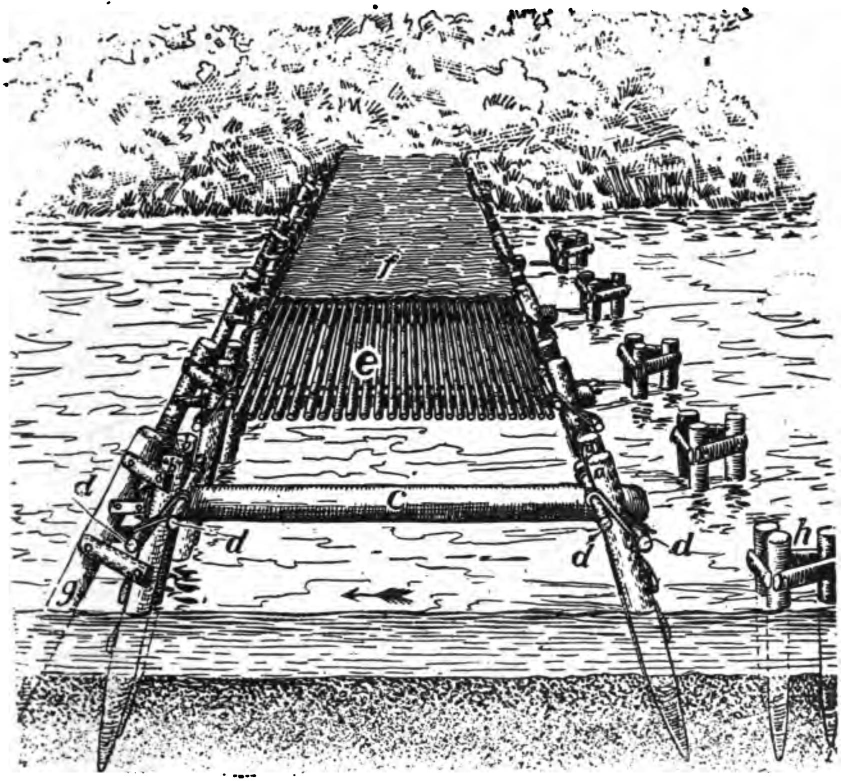


FIG. 1.

a. Double piles (upstream).
b. Double piles (downstream.)
c. Cap beam.
d. Lock fastening.
e. Stringers or balk.
f. Flooring.
g. Batter piles.
h. Pile clusters for catching drift.

It will thus be seen that the idea of building bridges in military operations is by no means new.

Permanent Defenses.

The character of the permanent defenses constructed around cities remained in general unchanged during this period, although there was a gradual increase in the size of the walls and in the dimensions of the ditches, in order to combat the growing efficiency of siege machinery. Similarly there were improvements in the height and strength of the towers and of the other arrangements for protecting the ditches along the weaker portions of the walls—that is, the curtains between the towers. Advantage was always taken of all natural features of the ground, and where the city lay on a river, advanced defenses or bridgeheads were made on the other side of the river for defending all the bridges.

The growing strength of naval fleets and the possibility of placing war machines on ships made it necessary to use care in the construction of the walls along the sea sides of seacoast cities and to place on these walls special machines for defense against vessels.

Nearly all larger cities surrounded themselves with defensive works, the size and character of which depended, of course, upon the situation, probable exposure to attack, and the wealth of the city. Later, during the days of the Roman peace, there was a tendency in Italy, in southern France and in a few other more peaceful sections of the empire for the larger cities to outgrow their walls and to become surrounded by suburban settlements. In general, these suburbs were unprotected or were surrounded by smaller and lighter defensive works.

In order to reduce the number of soldiers necessary for the defense of the extensive frontiers of the empire, the Romans constructed lines of permanent, or of at least semipermanent, defensive works along nearly all their land boundaries, the character of these works depending upon the needs of the case and the fighting qualities of the tribes beyond. In Great Britain they built completely across the island a continuous wall of moderate dimensions with a ditch outside. Along the German frontier they constructed a strong, continuous wall with a stockade or palisade; while along the African frontier, which faced the desert, they provided a series of detached forts or redoubts, similar in purpose and intention to the blockhouse forts used in our Middle West during the last century.

Field Fortification.

Perhaps the greatest development in the art of fortification during this period was the introduction by the Romans of the use of what may be called "field fortifications" as opposed to the permanent fortifications constructed in time of peace around large cities.

A Roman army in the enemy's country, or wherever the presence of the enemy was even suspected, never halted for a single night without surrounding its camp with a protective work consisting of a wall and ditch. The construction of such a defensive work necessarily required much labor, but the discipline of the Roman army was so excellent that it was always done. These defenses protected the army from a night assault and made it possible to leave but a small guard on duty so that the main portion of the army could sleep in peace.

If the army resumed its march in the morning, the fortified camp was abandoned, but if it was found desirable to remain in the camp for several days, its defenses were strengthened. So well were these works constructed that in the entire history of the Roman Empire only on very few occasions were the camps ever successfully attacked by the enemy.

Whenever the Romans began a siege they formed camps, similarly fortified, for the protection at least by night of their troops and supplies. Wherever they established an advance post, these outposts likewise were protected in some manner.

As an example of the character of field defenses constructed by the Romans, it may be well to give a description of the defenses constructed by Caesar at Alesia in Gaul, as described by him in the seventh book of his Commentaries, this being a unique case where we have a detailed account of the construction of defensive works, and of an attack on the same, written by a skilled soldier who was himself a participant.

Caesar, after having apparently completely subdued what he called Gaul—that is, France, Belgium, and the portion of Germany bordering on the Rhine—and having made two incursions into England, was surprised, during a temporary absence from Gaul, to learn of a sudden uprising of many of the Gallic tribes under a leader named Vercingetorix. With his usual enterprise, Caesar started to the aid of those of the Gallic tribes which still remained faithful to Rome but finding that the revolution was much more general than he had expected, he thought it well to withdraw all his troops and to concentrate in southeastern France and await reinforcements.

As soon as Caesar had started on this retreat, Vercingetorix thought he saw his opportunity and made an attempt with his cavalry to cut off Caesar's baggage train. He was defeated in this object, and made a hasty retreat, throwing the main portion of his army into the fortified town of Alesia, near the site of the present French city of Dijon. Caesar followed promptly, attacking the retreating Gauls and driving them almost panic stricken into the city.

The town was built on a high hill (fig 2, Pl. II). On the north and south sides this hill was bordered by rivers which united a short distance to the west of the town. On the east side was a plain some 3 miles long, but across this plain the Gauls had built a stone wall with a trench in front of it. An inspection having shown that the town was too strong to be taken except by siege, Caesar started to surround it with a line of fortfications. He pitched his camps in convenient situations and posted sentinels to keep his working parties from being interfered with by sorties. The line of fortification he built was some 11 miles long and contained 23 redoubts or forts. This work was, of course, interfered with by the Gauls, but as often as they came out, they were driven back into the city.

Vercingetorix, seeing himself about to be surrounded, sent out his cavalry by night, with instructions to rouse the entire country which should come to his aid as rapidly as possible with large reinforcements.

Caesar, learning of this, and foreseeing that he would be attacked by forces much outnumbering his own, proceeded to surround his camp on the outside by a fortified line 14 miles long. The character of this line as well as of the fortifications drawn up by him toward the town are described by him as follows (fig. 3, Pl. II):

Caesar being informed of the enemy's design by deserters and prisoners, constructed fortifications of this kind. He sunk a trench 20 feet wide with perpendicular sides so that the depth was equal to the width of the top. His other works he executed 400 feet away from that trench. His design was (as he was obliged to take in so large a circumference, that his whole work could not be readily manned) to guard against any sudden attack of the enemy by night or to prevent their throwing darts at his men while employed on the work. At the distance mentioned he dug two trenches 15 feet wide and the same in depth. The inner one, which was in low and level ground, he filled with water conveyed to it from the river. Behind these he constructed a line of ramparts 12 feet high and upon the ramparts breastworks with battlements. He inserted large, sharpened stakes projecting horizontally from the foot of the breastworks to prevent the enemy from scaling them (this is what is now called a "fraise"). At intervals of 80 feet he built small towers completely around the entire work. Finding it difficult to provide material for this work, some of which was at quite a distance from the camp, and to get corn, and at the same time to repulse the enemy who frequently made furious sorties, Caesar thought it necessary to make some addition to the works that they might be defended by a smaller number of men. Having provided the trunks of trees, he lopped their tops off and sharpened their points. He then dug a continuous trench 5 feet deep and set 5 rows of tree trunks in it, so that only the tops of the branches projected above the ground. These tops were fastened together and so interwoven that whoever attempted to pass impaled themselves on the sharp stakes. In front of these, conical pits 3 feet deep were dug in quincunx order and in these were sunk tapering stakes, the thickness of a man's thigh and sharpened at the top, and so placed that they projected only about 4 inches above the bottom of the pit. To give further strength and stability to these stakes 1 foot from the bottom was filled with trampled clay and the top of the pit was covered with brush so as to hide the pits. Eight rows of pits 3 feet apart were constructed. In front of these, stakes 1 foot long with iron hooks fastened to them were buried in the ground and were plentifully scattered throughout the whole front.

The interior line being completed, he followed the course of the country as the nature of the ground admitted, and constructed a fortification of a similar kind, 14 miles long, around his camp, reversing the order against the external foe.

* * * * * * *

About the time Caesar is completing these works a large army of Gauls, several times his own, arrives in front of Alesia. Confident in the power of numbers, the first to arrive attack the Roman works, but are defeated and driven back by a Roman sortie. After an intermission of a day, the Gauls, having prepared a large number of fascines, scaling ladders, and grappling hooks, march quietly out of their camp and under cover of darkness attack the Roman fortifications on the plain, and at the same time Vercingetorix makes a sortie from the town. As the Gauls approach they attempt to drive the Romans from the parapets by arrows and stones thrown by slings, and do considerable execution among the Romans, but the threatened places are reinforced by men drawn from other places not at that time subject to attack. As the Gauls come nearer they run into the pits and stockades constructed by the Romans, and many are killed or wounded. The fight lasts until daylight, when the Gauls withdraw to their camp.

The Gauls being thus twice repulsed, hold a consultation and decide to make a new attack on the north side of the town which the Romans had not been able to completely inclose, because it required too great a circle and on which they had been compelled to fix their defenses on uneven sloping ground. This hill was defended by two Roman legions.

Midday was set by the enemy as the time for making the attack. The night before, the attacking forces set out from their camp toward this hill, hiding before daybreak behind a neighboring mountain

PLATE II.

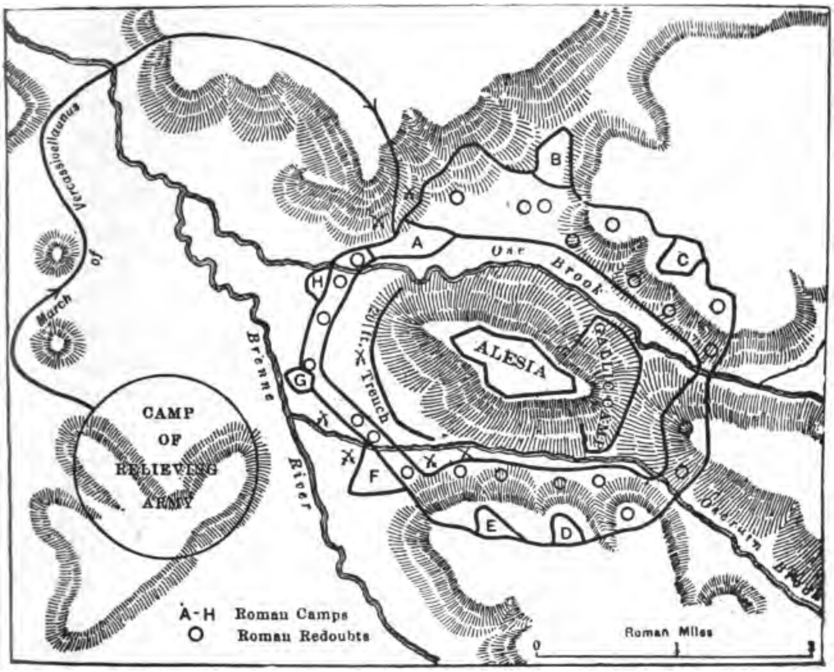


FIG. 2.

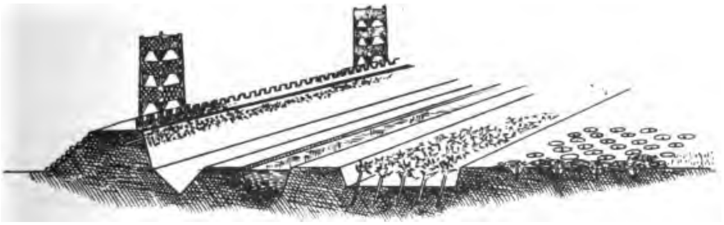


FIG. 3.—DETAILS OF FORTIFICATIONS AROUND ALESIA.

and refreshing themselves after the night's march and in preparation for the day's battle.

At the appointed time they advance to the attack, as do the Gauls on other parts of the line, and at the same time Vercingetorix sends a sortie from the town, so the Romans are obliged to defend themselves in nearly all places, both on the front and the rear at the same time. The most vigorous struggle takes place at the special hill mentioned, where the line of the Romans was built along the slope of the hill. This slope favored the assailants. From the top, arrows and darts are thrown into the Roman camp, and under cover of these and under the protection of testudos, formed with shields, the enemy succeeds in raising a mound against the Roman lines, which covers the obstacles which the Romans had made.

The defenders in this part of the lines become practically exhausted, so that Caesar is compelled to send reinforcements to them. In spite of these reinforcements the enemy succeeds in passing over the Roman obstacles by a passageway made with earth and fascines, and in driving the Romans from the towers by a multitude of darts and arrows and in breaking down a portion of the ramparts and parapets. Still other Roman reinforcements are drawn from the points of the line not seriously endangered and are sent to the threatened spot. These avail but little, and finally Caesar finds it necessary to visit the place in person. The battle is fast and furious, and is finally decided by an attack made on the enemy's rear by a portion of his cavalry which Caesar had managed to send out quietly through an unassailed portion of his line.

The Gauls are thus compelled to withdraw, and despairing of defeating Caesar, scatter to their homes. As soon as this happens Vercingetorix surrenders.

It may be said that these strong fortifications which Caesar constructed and which permitted him to throw reinforcements to threatened points saved his army, for it is evident from his own account that he was exceedingly hard pressed, and had it not been for these fortifications he must have been overwhelmed by the superior numbers of the Gauls. Had this happened, all of Gaul would have been lost to Rome at least for the time being, and though it probably would have been reconquered later, the history of the world would have been much changed. Surely, at least, we would have lost all that was due to Caesar's genius during the time that he ruled Rome.

From the description Caesar gives of the defenses he erected, it is evident that he was thoroughly familiar with all the essential principles of fortification, and with the function and use of obstacles.

In fact, he seems to have used nearly all the kinds of obstacles we now know, except the wire entanglement.

Siegecraft.

In siegecraft there was a most notable development during this period, resulting largely from an increased knowledge of the mechanical arts.

Although the knowledge of siege machinery had originated prior to this period, and the Persians had succeeded well in a number of sieges which they undertook, the conduct of sieges seems not to have become systematized until the days of Philip and Alexander of Macedon, who reduced siegecraft to a system and made a number of improvements.

The Romans in turn took up siegecraft in earnest, and by the days of the zenith of the empire had brought it to a stage of development which was not again equaled until the days of Vauban and his contemporary military engineers (Pl. III).

The first stage in all sieges at this time, as at all times, was, of course, an investment, to cut off the besieged from communication with the outside and thus prevent them from receiving reinforcements or supplies and to make them dependent upon such stores as they may have been able to lay in before hand or as they might be able to produce within the town.

A very prominent part in the attack was played by the war machines, such as catapults, ballistae, onagers, etc. These were worked by mechanical means, and cast into the city and against the walls thereof large missiles, such as very long arrows, beams of wood 6 to 10 feet long, large stones weighing occasionally as much as 1,000 pounds, balls of incendiary material, etc. The range of these machines is said to have been as much as 600 yards and for curved fire as much as 1,000 yards. These machines were put together beyond the range of the defenders' machines and were then slowly advanced as much as desired, and were protected in the new positions by screens, mantelets, etc.

Another type of structure perfected by the Romans for use in sieges was the siege tower, built of heavy timbers and mounted on wheels, so that when completed it could be rolled toward the city walls. These towers were made many stories high, in order to overtop if possible the city walls. (Caesar mentions one built 150 feet in height.) The upper stories of these towers when in use were occupied by archers to drive the defenders from the walls, or at least to interfere with the defenders' fire. From the lower stories battering rams were swung to make breaches in the walls. For the use of assaulting parties, these towers frequently had attached to their upper stories hinged bridges so hung that the outer ends of the

PLATE III.

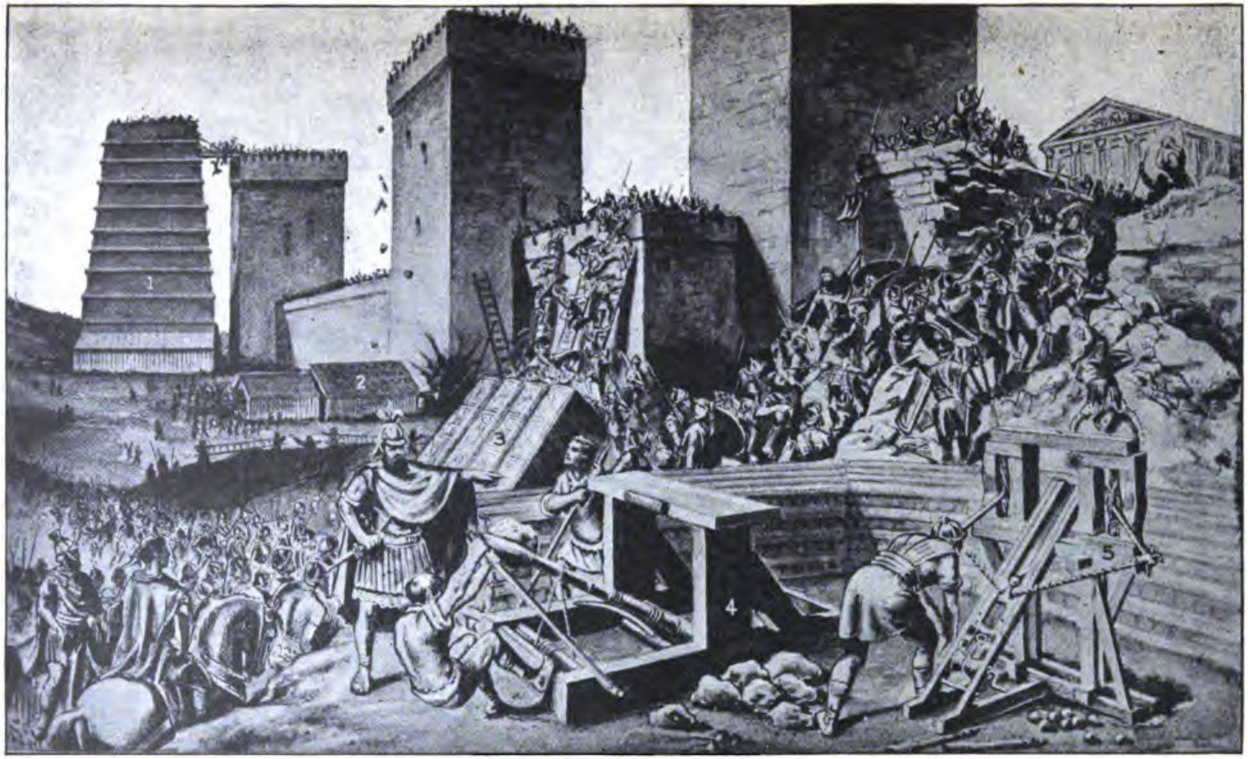


FIG. 4.—ROMAN SIEGE OPERATIONS.

1. Siege tower.
2. Portable shelter.
3. Testudo.
4. Onager.
5. Ballista or catapult.

bridges could be lowered to the tops of the walls when the towers had been pushed in close enough.

As the besieged would naturally try their utmost to destroy these towers, they had to be made very strong and as fire resisting as possible. For this purpose, use was made of rawhides and other noninflammable materials. It would further appear that, at least in some cases, barrels or small reservoirs of water were provided so that water would be available in case of fire. As a further aid to this use, hose was provided made of intestines of animals.

It is needless to say that these towers, when very tall and strong, must have been very heavy, but the Roman soldiers became extremely skillful in their use and managed to roll the towers forward, however heavy they might be.

As a quicker method of providing means for assaulting parties to reach the top of the wall, scaling ladders were mounted on wheeled platforms, which were then moved toward the wall.

In order to protect parties working at the foot of the walls, strong portable shelters or sheds were built and were then rolled forward on wheels. Under the protection of these sheds, battering rams could be used or the walls could be attacked by pick and shovel work.

Many other forms of portable shelters were used by the Romans, some consisting merely of very large shields with loopholes for one or two bowmen, some much larger for the shelter of larger squads or of war machines.

Sometimes when a merely temporary protection was needed, the Roman soldiers used what they called a "testudo." In forming this, the soldiers would draw close together and raise their shields over their heads so that they would overlap, and would thus protect not only themselves but others also who might crowd under. When formed, this "testudo" would move forward at command to the wall or even up a scaling ladder.

The Romans also became very adept in earthwork in connection with sieges. Of course, before the besieging towers or protecting sheds could be rolled against the city walls, the ditches, if any, had to be partially filled in. Earthworks were frequently thrown up also for the protection of their war machines and where the fire of missiles from the walls was very severe, approach trenches were dug, similar in purpose and character to those which became so common in siege work after the invention of gunpowder.

Occasionally during this period we hear of extremely extensive works being used in a siege, such as in the siege of Tyre. This city was built upon an island several hundred yards from the mainland, and due to this isolation had withstood successfully many previous sieges. Alexander the Great, however, constructed a mole from the mainland out to and along a considerable length of the city walls. Upon this mole he built his siege machinery and captured the city.

Mine warfare was introduced in siege operations in the way of galleries or tunnels dug to and under the city walls. As these tunnels were advanced, the weight of the masonry above was supported by framework and timber props and planking. When the area of the tunnel was considered sufficient, this timberwork was covered with incendiary material and was set on fire. As the timber burned, it was consumed, and the masonry being without proper support would fall down and thus open up a breach in the wall.

In one case Caesar used mine galleries dug through the earth until they intercepted the subterranean water courses which supplied a besieged city. With its water supply cut off, the city could but surrender quickly.

Mining operations were used also to some extent in the defense of a city; that is, when it was known that the besiegers were attempting to dig under the city walls, an effort was made by the besieged to tunnel into the besiegers' galleries and then to drive them out by smoke or by materials which when ignited would give off noxious gases.

Incendiary substances were invented and introduced into siege warfare. The chemical basis of most of these substances is understood to have been sulphur mixed with resin, tow, and other inflammable substances, which, ignited, are difficult to put out. This incendiary material would be thrown by the besiegers into the cities for the purpose of setting fire to timber structures or onto the walls for the purpose of driving away the defenders.

The defenders would also make use of the incendiary materials and attempt with them to destroy the war machinery and siege towers of the besiegers, or they would throw upon the besiegers working in the ditch burning oil, pitch, and similar substances.

As a partial protection against incendiary efforts, substances had been discovered which, applied to inflammable materials, would render them almost unburnable. Some formulas for preparing these substances have come down to us and are found to be more or less effective. Where possible, the timbers of the siege towers would, before being used, be soaked in such substances.

Of course, throughout the seige the defenders would reply as best they could to the attempt of the besiegers. They, too, had their war engines, with which they would try to destroy the war machines, siege towers, and shelters of the besiegers. In special cases, even more complicated machinery would be used by the defenders. Thus, during the defense of Syracuse in the second Punic War, Archimedes is said to have invented grapples and levers for seizing the Roman ships and lifting them completely out of the water. He is said also to have invented a system of burning mirrors for reflecting the sun's rays upon the ships and thus setting them on fire.

VALUE OF DEFENSIVE WORKS.

Throughout this period the defenses of fortified cities were of great value to the inhabitants both in war and in peace. In peace times they protected the cities against robbers and bandits, and toward the end of this period, from the raids of the barbarians. In war they frequently, but not always, had an important influence upon the course of the campaigns.

In campaigns—such as that of Alexander against the already decadent empire of Persia, and those during the struggles of the Roman civil wars, where the results were decided by pitched battles—the fortified cities played rather a minor part, and, of course, had shortly after the battle to make terms with the victors in the field campaigns. But in the internecine struggles between the Greek city States, in the campaigns of the Punic War, and in many of the wars toward the latter end of this period, the ability of a city to successfully withstand a siege—or probably it would be better to state the inability of the besiegers to capture a city—was not infrequently a most important if not the decisive element in a campaign or war.

Of course, in most cases, such an occurrence had only a local or temporary effect upon history, but occasionally the effects were more far reaching. Thus the inability of the Athenians to capture Syracuse during the so-called Peloponesian War, and the loss of men and matériel futilely wasted in the seige had a most important effect in bringing this war to a close and in removing Athens from its former primacy among the cities of Greece.

The success of Caesar in defending his temporary defenses erected around Alesia and the results thereof have already been mentioned, but perhaps the most notable occasion that ever occurred in all history where the defenses of a city played a vital part was during the second Punic War, when Hannibal found himself unable to attempt the seige and capture of Rome.

Shortly after the beginning of this war, the great Carthaginian leader, Hannibal, decided to carry the war into Italy, hoping to separate the Italian cities from their allegiance to Rome and to destroy the Roman power at its center. Forming a large army in Spain he passed northward to and through the southern part of France and accomplished what was then thought to be the impossible task of leading a large army over the Alps. Debouching into Italy he defeated and practically destroyed first one and then another army sent by the Romans against him. He then marched southward toward Rome, but lacking the equipment necessary for a siege or for an attack upon this strongly fortified city, he passed it by and proceeded to capture and turn from their allegiance the numerous cities of the Roman allies in central and southern Italy. The Romans, with haste, attempted to raise an army to overthrow Hannibal before he could be reinforced, and about a year later sent against him an army larger than any Rome had previously raised. This army attacked the Carthaginian forces at Cannae, but was defeated and almost annihilated, only a few stragglers finding their way back to Rome. Hannibal followed the stragglers for a short distance, but again feeling himself unable to make a successful siege—probably for lack of siege machinery or for the difficulty of provisioning his army during a siege—he again marched southward to complete his conquest of southern Italy.

For the next five or six years Hannibal was completely the master of field operations in Italy. He marched wherever he chose, and the Roman armies never dared to attack him, restricting their operations to cutting off his supplies or to attacking outlying detachments wherever possible.

During all this time Rome remained secure within her walls. Without them she must surely have fallen, leaving Carthage the mistress of the western world. What the course of history would have been had this happened can, of course, not even be conjectured, but it is certain that it would have been vastly different from what it was.

Recent archaeological investigations have given us an idea of the character of the defenses of Rome at this time. It was surrounded by a masonry wall with towers at intervals. What the height of the wall was, we do not know, but the excavations show that it was nearly 60 feet thick, and in front of it there was a ditch 100 feet wide and 30 feet deep. Such a wall, defended by desperate men of the type of the Roman soldiers of the day, was indeed an obstacle to cause even a genius like Hannibal to hesitate.

CHAPTER VII.

FORTIFICATION DURING THE MIDDLE AGES.

For the purposes of this book, the period to be discussed in this chapter and under the title above will be taken as the thousand years or so extending from the breaking up of the Western Roman Empire down to the time when the use of gunpowder began to have a really important influence in military matters.

Politically speaking, this period was one of great unrest, especially in the West. The empire of Rome, beset by the ever-increasing inroads of the semibarbaric tribes from the north, had struggled hard for its very existence; it had resorted to the expedient, first of taking these barbaric warriors into its legions, then of hiring one tribe to fight off another until finally this last expedient failed also. In the fifth century of our era, a number of these tribes, under the leadership of skillful chiefs, made almost simultaneous raids on the various Roman provinces in western and southern Europe and in northern Africa. The Western Empire fell to pieces and, from the ruins, these chiefs cut out for themselves a number of really independent kingdoms, though, for political reasons, they remained for some centuries under the nominal suzerainty of the emperor at Constantinople.

Nor did the disintegration stop here, for in time these kingdoms showed a tendency to divide up into duchies and the duchies into counties, the counties into baronies and so eventually, and in the course of several centuries, this resulted in the feudal system, where each little baron, though nominally owing fealty to his feudal superior, yet was, within the limit of his own domain, to all intents and purposes, independent.

The semibarbaric invaders cared little for the culture and industry of the inhabitants and, though enjoying the luxuries they found, they did almost nothing to encourage industry and commerce. The people became practically enslaved, and in a few generations, except in a few favored spots, much of the learning and skill that had been evolved through centuries became practically lost to the world. In preserving what was saved, the influence of the cities was most important. Their defensive walls protected them from the robber bands, which are so apt to form in periods of unrest and, to a great extent, even from the attacks of the barons. Thus protected, the inhabitants of the city were able to carry on their industrial occupations and to preserve for the future, to some extent at least, a part of the knowledge and skill of the past.

While this was going on in the west, the eastern half of the Roman Empire continued its separate, though checkered, career. In fact, not long after the Western Empire had fallen to pieces the eastern reached perhaps its greatest grandeur. Almost immediately thereafter, however, there began a slow but irregular decline. Under strong emperors a temporary revival would begin, to be followed shortly afterwards, however, by a greater decadence than before.

In eastern Europe the empire was beset by the inroads of slavonic tribes. Not only did these tribes make a number of successful invasions, but, occasionally, even for short periods, they were able to set up independent states within the general boundaries of the Eastern Empire. Later, however, these temporary states would fall again under the control of the central power at Constantinople.

In Asia the Eastern Empire had many enemies to contend against, but of these the most important was the Mohammedan power. Springing into existence quite suddenly, the Mohammedans rapidly extended their sway, westward along the north shore of Africa and into Spain, eastward into Persia, and northward over all of Syria, including the Holy Land, and even into Asia Minor. Their seizure of the Holy Land and their threatened conquest of the Eastern Empire, a Christian nation, awoke in western Europe an outbreak of religious fanaticism, as a result of which a number of crusades were started from Europe, one after the other, for the purpose of rescuing the Holy Land from the Mohammedans. Although nominally in sympathy with the eastern Christians against the Mohammedans, the crusaders really did great damage to the Byzantine Empire. In fact, at one time, certain western powers, nominally engaged in a crusade, took advantage of a dispute as to succession in the Eastern Empire and seized Constantinople, and set up therein a Latin Empire. The government of the Eastern Empire was temporarily moved elsewhere, but after about a half a century, the Latin Empire passed away and the center of the Eastern Empire returned to Constantinople, to continue for two centuries or more.

Eventually the excitement of the crusades wore off and the temporary conquests by the Christians were lost to the Turks, then the dominant element of the Mohammedan power. The Turks then started westward, aiming at the destruction of the already weakened Eastern Empire. Crossing into Europe, they cut away, one after the other, most of the European provinces of the empire and finally, after more than one attempt, were able in the middle of the fifteenth century to capture Constantinople and thus to wipe out the last remaining remnant of the former world-wide empire of Rome.

As a result of the information and learning brought back by returning crusaders, a revival of culture and industry began in the western world. The cities, and especially such of the larger cities of the older Roman Empire as had survived the dark ages, began again to flourish. The smaller barons began to lose their independence, and their baronies showed a tendency to become absorbed into larger duchies and these duchies into larger kingdoms. In general, it may be said that governmental agencies showed a tendency to centralization, with a resulting growth of law and order and a revival of commerce.

In the decadence of the arts and industries which occurred during the Dark Ages, the art of war participated.

The discipline and training which had enabled the Roman legions to conquer the world was lost. The Germanic tribes, trusting more to individual skill and efficiency than to discipline and organization, made no effort to continue the character of training which alone made the organization of the Roman armies possible. During the feudal period, each baron had his small independent force, and when a duke, a king, or other feudal superior needed an army, he would call upon his feudal subordinates to provide it, and each would come with his own body of troops, armed and trained as the particular baron might see fit. Under such conditions a large military force was not in the true sense of the word an army, but was merely a conglomeration of small and almost independent units.

As was stated in the preceding chapter, the Romans in early days had discarded the pike and spear as an infantry weapon, and had armed their legions with short swords only, relying upon the training and discipline of the legionary to bring about close action and success in this close action. For success with a short weapon when opposed to troops armed with longer weapons, the united action of well-trained and disciplined men is necessary, and such united action it was usually impossible to obtain with the troops raised amid the chaotic conditions resulting from the feudal system. Longer and more far-reaching weapons, therefore, again began to be common.

Once again the pikemen appeared as the most important element in such organized infantry as was maintained in central Europe during this period. The pikes now used were much shorter than those formerly carried by the Greeks and there appeared a tendency to add to the pikes near their heads hooklike or axlike attachments. transforming the pikes into peculiar weapons of which the halberd is a fair sample.

The more irregular infantry were armed with many different weapons, each country or locality seeming usually to have its own particular favorite. Thus, the Scotch seemed to prefer a large two-handed sword, the English the bow, and especially the long bow, in the use of which they became extremely skillful.

Tactical control, in the proper sense of the word, seems practically to have come to an end. A leader might start his men into battle, but no maneuvering during the battle was possible, nor does any such seem to have been attempted, except occasionally, and then only in the way of the sending in of a body of men that had been kept as a reserve, or in the withdrawal of a small force from an unengaged part of the line, to assist their friends in the mêlée at another. So poor was the tactical control that quite frequently a part of an army that had won a local success in one part of the battle line would turn at once to plundering the enemy's camp instead of going to the assistance of their heavily engaged and endangered friends, and would thus lose the battle in consequence.

The forces engaged in warfare were, as a rule, much smaller than had been common some centuries before. In fact, the conditions into which the roads and other communications had been allowed to fall were such as to make the united movements of a large army almost impossible. Siege trains were no longer known, and even provision and forage trains were seldom carried. Consequently, though an army had to concentrate to fight, it had, almost immediately afterwards, to scatter in order to subsist.

One of the most noticeable developments in this period was the growth of the importance of the mounted man. Throughout the days of Rome the principal arm had been the infantry. The cavalry had been an auxiliary only, but when the formation of proper tactical organizations of infantry had been forgotten and the infantry became unable to properly protect themselves against cavalry, the mounted men became the most important element of the army.

To protect themselves against the growing power of the bow and arrow the mounted men began to wear a body armor and this armor gradually increased in size and complexity until the cavalryman, or at least the mounted man of wealth, covered himself from head to foot with a complete suit of armor, and, in addition, he provided his horse with protecting armor for his head, neck, and a large portion of his body. These mounted men carried pikes and spears for the charge and short swords or daggers for the mêlée.

The gradual growth of the horseman's armor, in an attempt to protect him from the increasing power of arrows and other missiles, made him and his horse more and more unwieldy and made it difficult for him to maneuver. In the open field and against poorly trained infantry he was superior, but he could do little in a wooded country, and a long march or a long-continued battle were apt to exhaust both horse and man. On the horse and in the charge the cavalryman was most powerful. When on foot he was unwieldy and subject to attack from the rear. Once fallen on the ground he was helpless and a prey to any of the enemy that might desire to kill or capture him.

Later, and toward the end of the feudal era, the bowmen learned to act together and to plant stakes in front of themselves to keep back the hostile cavalry, and the pikemen likewise once again were trained to oppose a cavalry charge. These developments and the high cost of maintaining cavalry once again began to raise the infantry to their former place as the most important branch of the army.

During this time of chaotic conditions, the art of building defenses around cities likewise retrograded, and there were no new developments, at least in the West. The older permanent defenses were, of course, still in existence, and an effort was made by the larger cities to maintain these fortifications in serviceable condition, and as thus maintained they played a most important part in protecting the citizens from highwaymen, bandits, and marauders which the existing social conditions made possible, and even occasionally from an attack by robber barons.

In the East the only modification in defensive construction was a tendency to build, inside of the main line of defenses, successive interior lines which might be held if the outer main defenses were captured or breached. This, of itself, is considered an indication of decadence, for had the same amount of thought and labor been expended in improvements of the main defenses as was spent on these interior lines it would have made the city much less subject to capture.

The most important development in defensive works during this period was the tendency to construct individual castles. The feudal barons and dukes were almost constantly at war with one another and found it necessary to build and fortify castles of their own. At first, these castles were small and were not very strongly fortified, but as the wealth of the barons increased, the fortified castles became stronger and more complex. Later, and after the return of those who had taken part in the crusades and who had become familiar with the complicated fortifications then existent in the East, a new era in castle building began. Almost all of the defensive devices then existing in the city defenses of the East were copied, and especially the custom of placing different lines of defenses one within the other, with the idea that as one line after the other was captured by the assailants the defenders would withdraw successively to new defensive lines, finally taking refuge in the keep, the strongest of them all (figs. 5, 6, and 7, Pls. IV and V).

Great care was taken in selecting the sites for these castles, so as to make use of impassable natural obstacles as much as possible. High hills with precipices on one or more sides were considered particularly desirable sites. On the other sides, high and steep walls were built, crowned by battlements, from which a heavy fire of arrows, stones, and other missiles could be brought to bear upon the besiegers. Outside of the walls, deep dry or wet ditches were dug which could be crossed by drawbridges only. Towers and galleries were built at intervals and were so designed and provided with narrow loopholes as to completely protect the ditch and the weaker portions of the walls.

Many of these castles, of which quite a number still exist, were models of intricacy and of the engineering art of the day. To ordinary assaults they were impregnable, and nothing except a regular and lengthy siege was effective against them, and such sieges could be accomplished only by a royal army or by a concentration of the forces of a number of dukes or barons.

During the early part of this period, siegecraft became an unknown art in the West, and it did not revive until after the return of the crusaders, bringing with them the knowledge of the East. Such knowledge, however, was fragmentary; and even up to the end of the period the machinery used in the siege and the besiegers' skill had not begun to approach the perfection which they had had in the palmy days of Rome.

Fortunately for the world, the retrogression of all branches of the military art had been considerably slower in the East than in the West. The generals of the Byzantine Empire and the Arabian and Turkish rulers had shown an ability to organize and control large armies and to so train and discipline their forces as to keep them under excellent tactical control. This knowledge was, to some extent, absorbed by the crusaders, and thus found its way into western Europe.

The most revolutionary event in military art during this period—and perhaps at any time in the history of the world—was the introduction into western Europe of the use of gunpowder.

When the use of gunpowder in firearms was introduced is not exactly known, and it might appear at first sight as somewhat remarkable that an invention which was later to play so great a part in history should have received so little notice from the historians and chroniclers of the time. It should be noted, however, that the first firearms were very imperfect and were almost as dangerous to friends as to foes. The first cannon built were far inferior as machines for casting iron or stone balls to the mechanical apparatus already existing, and, consequently, cannon seemed to have been considered at

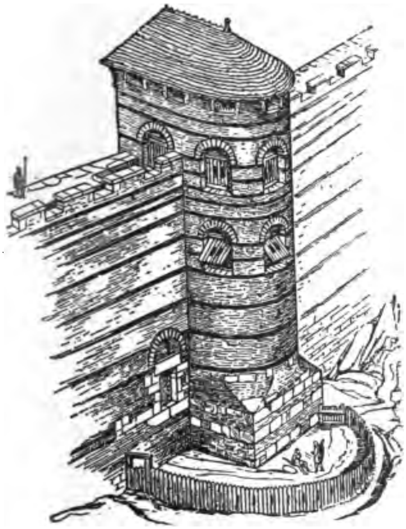


FIG. 5.—ONE OF THE TOWERS AT CARCASSONNE. OUTSIDE VIEW.

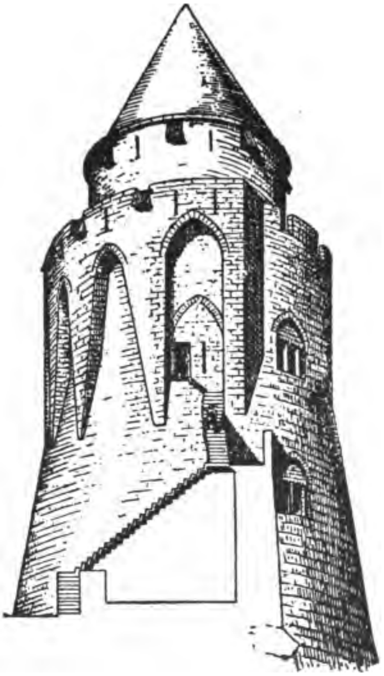


FIG. 6.—DONJON. CHATEAU GAILLARD.

From Encyclopædia Britannica, 1910.

first merely as auxiliaries or as imperfect substitutes for the older and more efficient mechanical apparatus.

The basis of the powder of the day was saltpeter. The manufacture of saltpeter seems to have been understood early in the thirteenth century and to have been used in that century for incendiary purposes, sometimes in connection with sulphur and sometimes without. It was gradually applied to making powder for use in muskets or cannon, but, of course, at first the powder was very poor. Small cannon were used by the Moors in Spain in the middle of the fourteenth century, but the cannon balls weighed less than a pound and had no effect against the masonry, although they were dangerous to human beings. Improvements were rapidly made, but in spite of these improvements, there is a record of regulations drawn up during the latter part of the fourteenth century for the defense of a French castle, in which the cannon, although large for the day, were evidently considered as being far inferior to the ballistae as weapons for throwing missiles.

In the early part of the fifteenth century, gunpowder was used in three classes of firearms: cannon, muskets—which though portable by hand were so large and heavy as to require while in action the support of a wooden prop or trestle, and the arquebus, which could be carried by a man and fired from the waist or shoulder. Later both the musket and the arquebus were much improved and became so similar that the one word "musket" was applied to both. The musket and arquebus were used by the infantry, but up to the end of the period mentioned—about the middle of the fifteenth century—they were still considered as auxiliary arms, the main weapon of the organized infantry being the pike.

In sieges, cannon had begun to be used both by the offense and by the defense in the early part of the fifteenth century, apparently, however, with but little effect until the siege of Constantinople by the Turks in 1463.

In this siege, both guns and mortars were used by the Turks, and guns, at least, by the defenders. Some of the mortars used by the Turks threw stone balls weighing as much as 700 pounds, and the mortars were of such efficiency and durability that some of the same mortars were actually used against the British Fleet in the early years of the nineteenth century. One very much larger gun was built by the Turks during this siege, but it burst on the fifth round, killing not only a number of Turks, but the designer and maker of the gun as well.

In an attempt to reply to these Turkish guns, cannon were mounted on top of the walls by the defenders, but it is reported that some of them did much more damage to the walls than they did to the enemy.

CHAPTER VIII.

THE FIRST CENTURIES OF GUNPOWDER.

Under the above somewhat indefinitely worded title, it is proposed to discuss the progress of the art of fortification and, incidentally, of the other branches of the art of war from the time when gunpowder first began to play a really effective part in warfare until about the middle of the nineteenth century.

The date, indefinitely stated as about the middle of the nineteenth century, has been chosen as the end of one of the periods into which this history of the development of the art of fortification is divided, because at about that time five important developments took place, either in matters pertaining to the art of war or in those having a great influence upon the art of war.

These five developments were:

(1) The general adoption of the steam engine for transportation purposes, both on land and sea.

(2) The introduction of iron or steel armor as a protection for ships or land defenses.

(3) The general adoption of rifling in both cannon and small arms.

(4) The general use of temporary fortifications in the field operations of an army.

(5) The general abandonment in permanent land fortifications of the principle of a closed enceinte and the substitution for it of a system of detached forts.

It is not intended to imply that all of these changes took place exactly simultaneously, or that their introduction or general adoption was a very sudden thing, but rather that the date mentioned marks the division between the time when they were not in general use and the time that they were.

For instance, the expansive power of steam had been known for about 2,000 years. It had been applied for over 50 years for certain specific purposes, such as pumping. It had, for a few decades, been utilized to some extent in steamboats, and for a slightly shorter time in railroad locomotives; but the middle of the last century, in general terms, may be said to mark the beginning of the rapid development of railroad construction on land, and the use of steam vessels for ocean navigation.

The application of steel and iron armor was but a revival on a larger scale of what had been attempted in the personal armor of the horseman in the days of chivalry. During the early part of the nineteenth century, experiments were made in the application of iron armor for protective purposes, and by about the middle of the century, it was adopted for the shutters protecting casemate embrasures on land and the portholes on shipboard. Its general extension to use as a side protection for ships followed very shortly afterwards.

The idea of increasing the range of guns and improving the accuracy of fire by the use of rifling and the consequent rotation of the projectile in flight is nothing new. It had been invented in the first quarter of the sixteenth century, and had at various times been actually used in war—in general, however, without much success.

Prior to our own Revolutionary War, the hand rifle was common among our American hunters, who made use of it with great success against the British regulars, in the kind of "Indian" fighting which was frequently utilized in the Revolutionary War. As a result of this success, the rifle was, shortly after our Revolutionary War, adopted for the use of certain special troops in the British, French, and other continental armies. In the British Army, some of these organizations then armed with rifles have continued to use it ever since, but so inefficient was the rifle of the day that Napoleon took it away from the French organizations which had been armed with it and replaced it by the smoothbore musket. However, about the middle of the last century—the time now under discussion—many inventions were made, greatly improving the rifle, with the result that shortly thereafter there was a general introduction of the rifle as the standard infantry weapon.

Rifling had been used in cannon at intervals for a couple of centuries, but its general introduction into cannon did not take place until the time mentioned. Before that time, the large majority of cannon used were smoothbore At that time or shortly afterwards, the number of rifled cannon began to outnumber the smoothbores.

The erection of temporary protective works had been customary in siege operations for many centuries, but their use in open field operations had been rare. To be sure, they had occasionally been used by the Romans, but during the middle ages the idea was almost lost sight of, unless the stakes which the English archers occasionally placed in front of them to protect themselves against cavalry charges may be considered as works of this kind. During Napoleonic times, field fortifications were used to a slight extent by the British in Spain and Portugal, as will hereinafter be noted, but they seem to have been but seldom used by the French Armies. Consequently, it may be said in general that before the time mentioned, field fortifications were used by field armies on special occasions only, but in the wars since that time they have been very extensively used.

The principle of using a detached work to occupy or hold an important site as an adjunct to the main defense is, of course, quite old, and the numerous outworks used, as will hereinafter be shown, in the defensive systems in the seventeenth and eighteenth centuries were approximations to the use of the detached fort, but about the middle of the nineteenth century their use became quite general.

Improvement in cannon and the introduction of the rifled principle had increased the bombarding range of the artillery to several miles. To protect cities from bombardment, therefore, the defensive works had to be thrown far to the front so as to keep the enemy beyond cannon range of the city protected. The throwing of these forts forward in this way increased the perimeter of the defensive works so greatly that the use of the closed enceinte became impossible, and consequently the custom grew up of surrounding the defended cities with a series of strong detached forts or redoubts to form the main line of defense, these redoubts to be connected by lines of rifle pits or other lighter defenses. The closed enceinte of the city was thus relegated to a position of secondary importance or became a sort of last hope.

GENERAL HISTORY.

No attempt will be made to go into the detailed history of the world during this period. In general, the tendency to concentration of authority shown in the latter part of the preceding period was continued, the smaller baronies and duchies being gradually drawn within the rule of a few centralized monarchical governments. This tendency to centralization of authority was accompanied by a general spread of law and order throughout the community and by a rapid development of the country in population, agriculture, and industrial pursuits.

This development, of course, did not take place with perfect regularity as it was frequently interfered with, at least in certain localities, by the devastating results of war. Of the wars during this period, perhaps the most disastrous to the countries engaged was the Thirty Years' War, which occurred in the first half of the seventeenth century. The battle ground of this war spread over nearly all of Germany and extended occasionally outside of Germany. A large portion of the soldiers engaged were mercenaries, who devastated the country they passed through, doing almost as much damage amongst friends as amongst foes. It is stated by some historians that the population of this section was reduced during these 30 years to one-third of what it had been before, and that in the loss of industrial enterprise the country was set back practically a century.

The general extension in industry caused a rapid increase in commerce, and for the assistance of this commerce extensive systems of well-paved and constructed highways were gradually built in all parts of western Europe, interconnecting all the principal towns. In general, these highways were intended for commercial purposes mainly, but they served during wartime for the transportation of armies and their supplies. In a few cases, however, special roads were constructed mainly on account of their influence in military campaigns, notably by Napoleon. These should be considered as examples of the offensive use of fortifications.

This period also was marked by great maritime discoveries and the colonization of many distant lands, but though, in certain connections, of great importance, it can not be said that either the exploration of these distant lands or the growth of any of its colonies were the cause of any special developments in land warfare.

Of course, in all colonies, it was necessary for the colonists to protect themselves against the aborigines, and they had to adapt their method of fighting to the circumstances of the localities. Since much of this fighting took place in heavily wooded and broken country, and the forces on both sides were not large, the colonists soon learned to take advantage of the protection afforded by trees, stumps, rocks, etc., and occasionally to add to the natural protection by rough construction of timber or stone. It is thought probable that it was the experience in the kind of fighting used by our troops against the Indians in the western part of the United States that caused the rapid introduction of field fortfications during our Civil War. It would appear, however, that up to about the end of this period, this method of fighting had no effect upon the field operations in use by armies in Europe.

GENERAL EFFECTS OF GUNPOWDER ON WARFARE.

As was stated in the preceding chapter, it was more than a century after the manufacture of gunpowder became known in Europe before it really began to play any important part in actual warfare; but when the effectiveness of firearms in warfare was once known, improvements and developments followed rapidly, and their effect upon the art of war was practically revolutionary.

The introduction of firearms and the rapid improvements in their efficiency soon caused a great change in the design of defensive works; but as this is one of the principal subjects of this book, it will not be further considered here but will be treated more at length in special sections of this chapter.

Field Artillery.

Owing to the general poorness of communications, it was some time after cannon had been successfully used in siege work before they were introduced in field operations and were used in battles in the open. Once put to this use, they caused a rapid evolution in tactical formations, resulting generally in the diminished use of massed formations within range of the enemy's cannon except at night.

At first, the design of field artillery was very crude, the range small, and the rate of fire very slow. Moreover, the roads were so poor that the artillery could be moved but slowly, but before long it became such an important branch of the service as to be almost the deciding element in the rate of travel of an army.

The first war in which field artillery seems to have played an important part in field operations is the so-called Thirty Years' War which took place in the first half of the seventeenth century. At this time, it was still the custom to form the infantry in very deep masses with the cavalry on the flanks, and the battles were generally decided by the result of the charge in mass. As an assistance to this mass attack, the generals in this war began to use their artillery in the very beginning of the action to fire upon the massed infantry of the enemy, for the purpose of causing as much destruction as possible, breaking up their organization and injuring their morale. So effectively was this done that several battles seem to have been decided mainly by a superiority of artillery. From that time on, one of the principal aims of army commanders was to insure that their artillery should be superior, preferably in number and certainly in efficiency, to that of the enemy.

Infantry.

As was stated in the preceding chapter, the musket and arquebus were first considered as auxiliary weapons, and even for some centuries after their introduction, the main infantry soldiers were the pikemen; the rapid development, however, in portable firearms soon changed all this. First, musketeers were scattered among the pikemen, then an entire rank were armed with muskets. Finally the pike was done away with, and for it was substituted the bayonet, which could be attached to the muzzles of the muskets.

As the rate of fire of muskets at first was very slow, the infantry was still formed several ranks deep, the duties of the rear ranks being to load the muskets and pass them to the front ranks to be fired. Gradually, however, owing to improvements in the muskets and to the influence of the field artillery, the number of ranks was reduced, and by the end of this period two ranks had become the standard infantry formation.

Cavalry.

At the beginning of this period the cavalry was still a very important arm, relying upon shock action and being armed with lances and swords. The range of the infantry muskets was so small that the cavalry in a charge upon infantry could pass so rapidly over the small area covered by infantry fire as to be practically unbroken at the moment of contact; consequently the infantry could resist cavalry only when formed in squares, with their bayonets pointed outward. The cavalry still remained for a long time a very important arm, and whenever it was known to be present it was necessary for the infantry to remain in a square formation, which was not an especially efficient one for an infantry charge, and, furthermore, subjected the infantry to great loss from artillery fire.

As the range of the infantry firearm increased the comparative value of the cavalry became less, because in charging efficient infantry, cavalry would suffer very greatly, and their formation would be broken up before they could reach the line. It thus became a maxim toward the end of this period that it was suicidal for cavalry to charge unbroken infantry.

Consequently it became one of the favored tactics of the day—used many times by Napoleon—to make a threat of a cavalry charge, forcing the enemy's infantry to form into squares, and then to concentrate upon the infantry squares all available artillery, holding the cavalry charge until the infantry squares had been badly broken up or had become demoralized by artillery fire.

Toward the latter end of this period it became customary to arm the cavalry with revolvers for use in the mêlée, in addition to the sword. Later on the carbine was also added, and certain branches of the cavalry became really mounted infantry, the horses being used rather for rapidly moving from place to place, and the fighting being done on foot almost as infantry. This was especially the case in unsettled countries, such as the Indian fighting in the western part of the United States.

Tactics.

The tactical mobility which had been so highly developed amongst the Roman troops was to a great extent lost during the Middle Ages, and had not been revived at the beginning of this period. In fact, as late as about a century and a half after this period had begun, that is, until after the beginning of the Thirty Years' War, it was still customary for troops to be drawn up facing each other in the order of battle, and after a charge had been started by either side, almost no tactical movements were possible. Later, however, the Swedish king, Gustavus Adolphus, reintroduced the principle of maneuvering on the field of battle and succeeded in bringing his es to such a state of training as to make this possible. This was ied by the other generals in this war, and from that time forward efully trained troops were able, to some extent at least, to maneu- even under fire. The improvement in this respect was slow but ady, and by the time of the Napoleonic wars, the ability of troops maneuver tactically had reached a stage never known before.

ategy.

During this period there was a steady growth in the knowledge of rategy which began to be exemplified in some of the campaigns of e Thirty Years' War. In general, this knowledge steadily in-eased, though there were times when remarkable lack of the prin-ples of strategy seems to have been displayed. This was especially ue in some of the campaigns fought around the frontiers of France nder Louis XIV. This warfare degenerated almost into a succes-ion of sieges, either successful or unsuccessful, the few battles fought n the open being generally due to an attempt to relieve a fortified lace or to supply an army engaged in a siege. In several cases, the French generals won important field battles, but obtained practically no results from these successes because of a hesitancy to advance ahead of the general line of the troops engaged in sieges. Such failures have been most unfavorably commented on by military historians.

A hitherto unexampled knowledge of strategy seems to have been possessed by Frederick the Great of Prussia, who knew how, in his campaigns, to concentrate his troops where the enemy was weakest and to obtain great secondary results from comparatively minor battles. To be sure, much of his success was due to his well organized army and its ability to maneuver; also a considerable part of his success seems to have been due to the mistakes of his enemies. Nevertheless, he must be credited with great skill in strategical combinations. A half century later, Frederick was followed by Napoleon, probably the greatest military genius that ever lived. Napoleon's campaigns in many respects are marvels, not only in tactical dispositions, but in the display of what may be called political as well as military strategy.

Logistics.

Except in rare intervals throughout nearly all of this period, the supply of an army in the field continued to be a very difficult undertaking.

At the beginning of the period, the existing roads were extremely poor and the mechanical difficulties of bringing up supplies for an army were so great, except on rare occasions, that it was necessary for an army to live on the country where it happened to be. The consequence was that an army, while on the march, had to scatter to live, and practically devastated the country through which it passed. This was especially true, as has been noted above, during the Thirty Years' War; and during that war, the situation was made even worse from the fact that for considerable periods the mercenary armies were not only not supplied but were not even paid, and therefore, felt themselves justified in taking not only what they needed to eat but anything portable that was of sufficient value to take with them, even when in a supposedly friendly country.

Later, of course, the paved roads which had been built mainly for commercial purposes, served for the passage of an army and to some extent for the transport of its supplies, and a number of the battles fought during the latter part of the seventeenth and the early part of the eighteenth century were in connection with an attack or defense of convoys of supplies.

Toward the end of this period, the question of supplies had been somewhat more systematized and a great deal of attention was paid to it by Napoleon, who is said to have remarked that "An army crawls on its belly," meaning that its rate of progress is dependent to a great extent upon the rate at which food can be brought to it.

Even, however, in the Napoleonic wars, there were many occasions when the questions of supply were not properly attended to. Thus, in the fall of 1805, Napoleon's concentration upon the Austrians in the upper Danube region was made so rapidly that his army got far ahead of its supplies, and for a week or so were in very straightened circumstances, the Austrians having but recently denuded the country through which Napoleon had to pass. In the next year, even the well-organized Prussian Army, maneuvering in a portion of its own country, was nearly starved, and Napoleon's wonderful success at Jena and Auerstadt is said to have been due in part to poor conditions of the Prussian commissariat.

DEFENSIVE WORKS.

The Profile.

As has been stated, cannon, about the middle of the fifteenth century, had shown at Constantinople their ability to make breaches in masonry walls. A few years afterward, they had been used with great success by one king of France in forcing the early surrender of the castles of the feudal barons, and a little later by another French king in capturing fortified cities in Italy. They, therefore, at once became an essential element of all siege operations and, therefore, a necessity for all defensive works subject to siege.

The fortification engineer was thus presented with two problems; first, how to protect from cannon the walls of fortifications then in

PLATE VI.

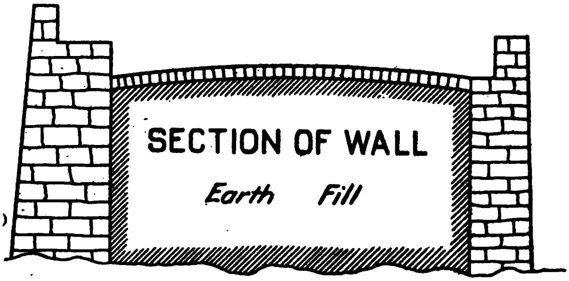


FIG. 8.

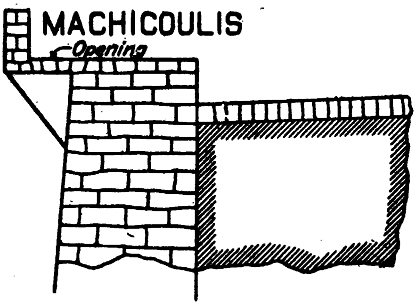


FIG. 9.

existence; second, how to construct fortifications for the future that could withstand cannon fire.

The first problem could be solved only by protecting existing walls as much as possible by earthwork or by constructing entirely new defenses. The second problem required considerable study, and before discussing this problem, it may be well to give a more detailed description, than has been heretofore given, of the character of construction used in the defensive walls of the time.

The general character of defensive walls had changed but little from prehistoric times. They were intended primarily as obstacles against an assault. The necessity of resisting siege machinery had caused them to be made very thick, and from the days of the Romans they had been made very high so as not to be easily overtopped by siege towers.

The cost of making a solid wall of these dimensions was prohibitive, and consequently the custom had grown up of building only the two face-walls of masonry and of filling in the interior between the face walls with earth (fig. 8, Pl. VI). In order to permit the rapid movement of troops along the top of the wall, and in this manner the reinforcement of a threatened place, the tops of the walls were finished as a paved roadway. To keep people walking on this roadway from falling off, a low parapet wall was raised along the top of the rear of the wall; and to protect people on the roadway from the sight of the enemy and, to some extent, from missiles, the top of the wall in front was made somewhat higher. It was necessary, however, to enable the defenders to fire from the wall and, consequently, immediately in the rear of the top of the outer face of the wall, there was built a raised platform or banquette, upon which the soldiers might stand while discharging arrows and other missiles at the enemy. To give these soldiers partial protection, a wall waist high was at first built in front of them, but when the long bow was introduced, it was found necessary, for the use of the archers, to provide slots at intervals extending down to nearly the banquette level. For the partial protection of the men firing through these slots, the wall between the slots was built man-high; and thus there grew up the custom of finishing the tops of the walls with battlements or crenelations, similar to those shown on the castle, which is the insignia of the Corps of Engineers.

It is evident that persons working close in to the foot of the wall were comparatively safe from the fire of the defenders on top. In order to prevent this, two methods were adopted; one, projecting the battlements and the banquette forward in front of the face of the wall, and providing openings in the floor of these projecting galleries, through which fire might be directed downward. These were called machicoulis galleries, but they seem to have been used more frequently in individual castles than in the walls around cities (fig. 9, Pl. VI).

The other method of providing for this close defense was the construction of towers at intervals along the walls. These towers were built so as to project to the front, thus furnishing flanks from which fire close along the face of the wall could be obtained (fig. 5, Pl. IV). In order to increase the volume of this flank fire and still not weaken the lower portions of the tower, the towers were built considerably higher than the walls, and were provided in these upper stories with numerous loopholes. These had the additional advantage of permitting a strong fire upon a portion of the wall which might have temporarily fallen into the hands of an assaulting party of the enemy.

Of course, the foot of any one tower was as unprotected from fire coming from the tower itself as the foot of the wall proper had been without the tower; and, consequently, the towers had to be placed so close together that each could bring a strong fire in front of the next tower on either side; that is, so that the base of each tower was covered by the flank fire from the nearest tower on either side.

When the walls, built in the manner above described, were first exposed to cannon fire and a breach was made, the interior filling would run out through the breach. This would not only seriously injure and probably bring down the portion of the wall above, but would furnish a practicable communication, up which the assaulting party might climb.

The first tendency of the fortification engineer of the time was, of course, to strengthen the wall so as to try to make it sufficiently resistant to the fire of cannon. The methods used at the time for mounting siege cannon were mechanically poor, and the manner of aiming them somewhat crude. Consequently, the projectiles were certain to scatter a great deal, and it must have taken a long time to get the shot to fall sufficiently close together to form a breach. For this reason it could but have seemed to the engineer of the day—ignorant of the future development of cannon—that if the walls could be made just a little stronger they might possibly be able to withstand the effect of cannon shot.

The first attempt in this direction was to increase the thickness of the facing wall. It was soon found that to attempt this throughout the whole length of the wall was too expensive, and it was, therefore, done at intervals only, so as to reduce the damage that might be done by a breach. In other words, counterforts were provided at the back of the wall (fig. 10, Pl. VII).

The next step was to build in rear of the wall and between these counterforts several tiers of what were called relieving arches.

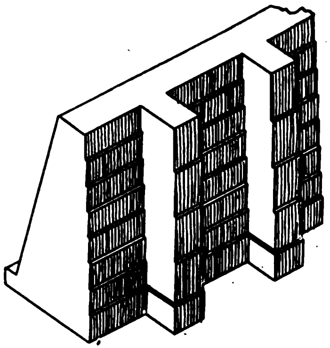


Fig. 10

SCARP WALL WITH COUNTERFORTS

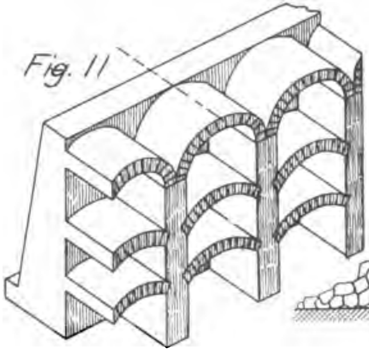


Fig. 11

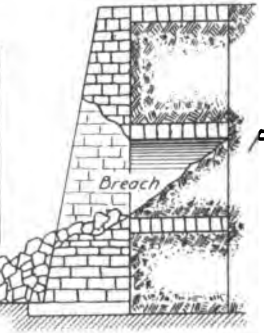


Fig. 12

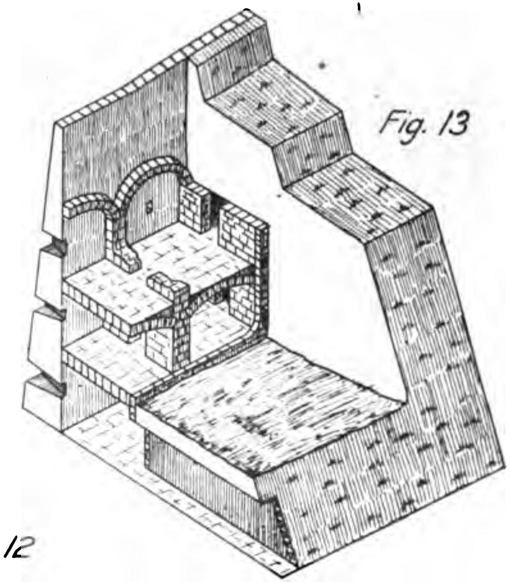


Fig. 13

WALL WITH RELIEVING
ARCHES AND CASEMATES

SCARP WALL WITH RELIEVING ARCHES

These made it more difficult to make breaches, and when breaches were made, the amount of earth which would run out was greatly diminished (figs. 11 and 12, Pl. VII).

The efforts above mentioned were in the direction of strengthening the wall, but other efforts were made, based upon another and more correct principle—that of increasing the volume of fire from the wall.

In the chapter on combat, it was shown, that, in general, a force on the offensive must be stronger than a force on the defensive, and it had become, therefore, a maxim that in a siege the attackers' artillery must have a superiority of fire over the defenders'. It was thought, therefore, that if the volume of fire from the wall could be made sufficiently strong, a successful siege was impossible, since the defenders with their superiority of fire could destroy the besieging batteries as fast as they were erected.

Consequently, the effort was made to place cannon as close together as possible on the tops of the walls; and to make the volume of fire even greater, the arches designed to strengthen the wall were utilized as emplacements for guns, loopholes being provided where necessary. This was the origin of the so-called "casemate" batteries (fig. 13, Pl. VII).

This increased volume of fire increased the difficulty of a siege and made much greater the amount of artillery which must be possessed by an enemy contemplating a siege. If, however, the enemy had sufficient artillery to make a serious attack, the walls were still vulnerable.

Before the middle of the sixteenth century, it had become evident that a high wall exposed to view and fire was subject to destruction. The wall as an obstacle had to be retained; but to insure its preservation, it had to be hidden at least from the sight of the enemy. Consequently, recourse was had to digging the ditch very deep, using the scarp wall as the main obstacle and building a counterscarp wall high enough to hide the scarp wall from sight and to protect it to a great extent from cannon fire (fig. 14, Pl. VIII).

Prior to this time, the ditch had sometimes been present and sometimes not. Its main function had been to increase the relief of the wall over the ground immediately in its front, and later to act as an obstacle to the forward movement of siege towers and other siege structures. Under the new conditions, the ditch became absolutely essential.

One of the functions of the high wall had been to furnish sites for the guns of the defense. When the high wall was done away with, some other place from which the defenders might deliver their fire was necessary, and this place had to have considerable command. Consequently, in the rear of the scarp wall a large earthen rampart was built, having earthen slopes in front and gun emplacements or infantry parapets at the top.

The rear of this rampart was sometimes made as an earthen slope, but more commonly as a wall into which were built rooms, used as magazines, quarters, etc. In front of the counterscarp wall an earthen embankment was placed. This was made quite high so as to give additional protection to the scarp wall, but in order that it might form no lurking place for the enemy during his advance, it was kept well below the top of the rampart and was finished off at the top with a smooth slope known as the glacis, all points of which were easily seen and were exposed to fire from the main ramparts of the fort.

As an additional means of defense, the rear part of this glacis close to the wall was finished as an infantry parapet, and to permit the defenders to move freely behind the glacis from one place to another, a communication known as the covered way was built along and adjacent to the top of the counterscarp wall.

The changes resulted in the typical form of profile shown in figure 14, Plate VIII.

This general type of profile, somewhat slowly evolved, remained in use—with slight modifications—for several centuries. In fact, it was extensively utilized in this country in a number of seacoast forts constructed on our coasts during the first half of the last century.

Of course, there were many variations in this profile. Sometimes the scarp wall was made nearly as high as the counterscarp. This was more usual in the early days; later, it was made much lower so as to give it protection from plunging fire. Sometimes the exterior slope of the rampart came down to near the outer edge of the top of the scarp wall; sometimes it was pushed further to the rear, leaving a berm along the top of the wall. Sometimes the slope was pushed still further to the rear and the berm was lowered some 6 feet or so behind the top of the scarp wall so as to make a concealed walk way behind the top of the scarp wall (fig. 15, Pl. VIII). Loopholes were then made in the upper part of the scarp wall so that men standing on the walk way could fire into the ditch or across the ditch into the covered way behind the glacis. This arrangement became known as a "semi-detached scarp."

Later, the same idea was carried further, the berm or walk way being lowered until it was but little above the bottom of the ditch and the scarp wall becoming but little more than an obstacle built in the ditch (fig. 16, Pl. VIII). This form, known as the "detached scarp," did not come in common use until after the end of the period now under discussion, but was later extensively used by the Germans

Fig. 14
TYPICAL PROFILE
OF A
FORTIFICATION

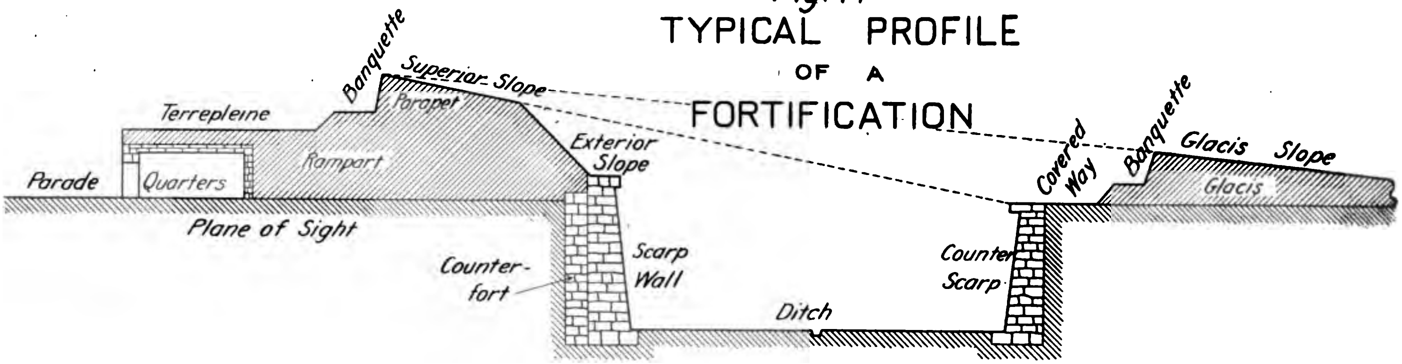


Fig. 15
SEMI-DETACHED
SCARP

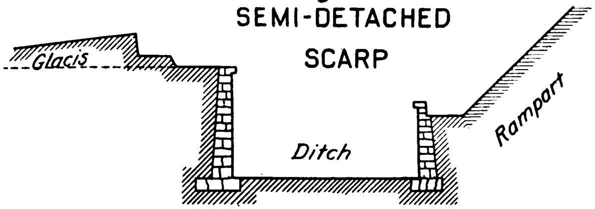
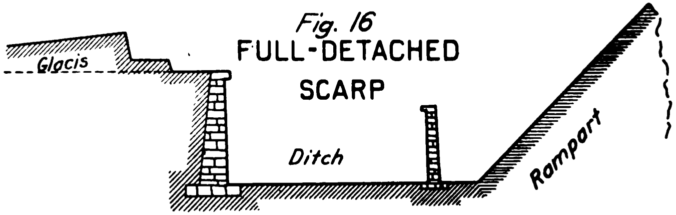


Fig. 16
FULL-DETACHED
SCARP



in their detached forts built in the latter half of the nineteenth century.

The variations just mentioned, resulting in the development of the semidetached and detached scarp, were, of course, attempts to protect the scarp wall more and more from the disastrous results of concentrated "curved" fire, made possible by the continued advance in ordnance, and were introduced only as they were shown to be necessary.

In the earlier days, various attempts were made to protect, at least, the lower part of the scarp by building in the wider parts of the ditch or in the ditches of outworks additional structures to catch and render comparatively harmless projectiles which might otherwise damage the scarp.

Evolution of the Bastioned Trace.

As was stated before, the flank defense of the older walls had been provided for by tall towers, projecting from the walls at intervals. When it was found impossible to maintain the masonry walls themselves, the towers, of course, had to go also. The flank defense, of course, had still to be provided for. Instead of doing this by tall projecting towers, as heretofore, it was now done by low projections from the walls certainly no higher than the walls themselves and frequently lower.

Among the earliest examples of these low projections are some small towers, or small "bastions" as they were afterward called, having the general shape of the ace of spades (see fig. 17, Pl. IX, which shows a horizontal section of an early bastion supposed to have been built about 1528). It will be noted that fire may be brought to bear on the ditch in front of the tower through loopholes opening to the front, and in front of the curtain wall by casemates in the neck or base, connecting the bastion with the wall proper.

It is evident that where a low bastion is thus built out in front of the wall, the ditch in front of it is not as wide, and therefore not as difficult to cross as it would be without the bastion, unless the counterscarp wall also is moved to the front. This moves the glacis further away so that it gives less protection to the part of the wall from which the bastion projects. This difficulty was met by raising the bastion, or at least, its front faces, to at least the same height as the wall proper. Soon the wall in the rear of the bastion was omitted and the bastion became an essential part of the trace.

At first the bastions were small and but little effort was made to secure a flanking fire along the ditch in front of them. These small bastions were, however, soon found to be cramped, and there was a tendency to enlarge them and to bring a flank fire in front of them.

In this way there grew up the typical bastioned trace, shown as figure 18, Plate IX.

The theory upon which the bastioned trace was based is quite simple. The faces of the two bastions a–b and e–f and the curtain c–d permit fire to the front. The flanks b–c and d–e are intended for flank fire along the curtain and the face of the next bastion.

To insure this flank fire along the face of the bastion, it is evident that "d" may not be to the rear of a–b prolonged, or "c" behind f–e prolonged, and that d–e must be made nearly perpendicular to the prolongation of a–b, and likewise b–c nearly perpendicular to the prolongation of f–e. Further, the ditch in front of "a" must not be beyond effective gunfire from and preferably within musketry range of the flank d–e, and the curtain c–d must be so long and the superior slope of the flanks b–c and d–e, respectively, so steep that fire from these flanks may strike the bottom of the ditch at the center of the curtain, so that each flank may cover with its fire the further half of the curtain.

In a fortress built on this trace and designed with the proper relation between the dimensions and directions of the various sides, the bastions which are the salients, and therefore theoretically the weakest points, and presumably the points most liable to be attacked, have their scarp walls protected from breaching by the counterscarp and glacis which here are in close. The flanks which are most exposed to breaching fire coming along the ditch can be reached only by batteries installed close in under the fire from the farther face of the neighboring bastion. The curtain, which is the most retired portion of the front, and presumably, therefore, the most difficult for an assaulting party to reach, is the least thoroughly protected from a breaching fire, since in front of this curtain the ditch is widest.

The bastioned trace has, therefore, many advantages, and these have been sufficient, in spite of its defects, which will be mentioned later, to make it for about three centuries the most commonly adopted standard. It arose in a crude form among the Italian engineers of the early part of the sixteenth century, was gradually improved, and was brought, in a simple form, to its highest perfection about a century and a half later by Vauban and his contemporary French engineers. It later became much more complicated so as to almost have lost resemblance to its original form.

Still later, in the early part of the last century, in a simplified form, it again became the standard upon which were designed many of the permanent seacoast forts erected along the shores of the United States. There were many of these, and quite a number are still in existence. The largest is Fort Monroe, at the entrance to Hampton Roads, Va., a closed work having seven bastions and a moat nearly a mile and a half long measured along the scarp wall (figs. 19 and 20, Plate X).

PLATE IX.

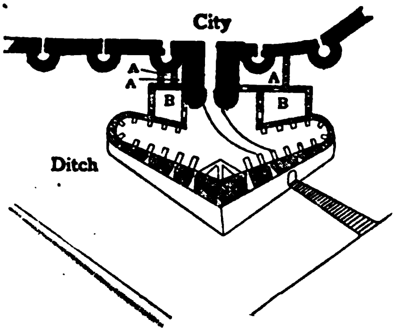


FIG. 17.—BASTION AT TROYES.

From Encyclopædia Britannica, 1910.

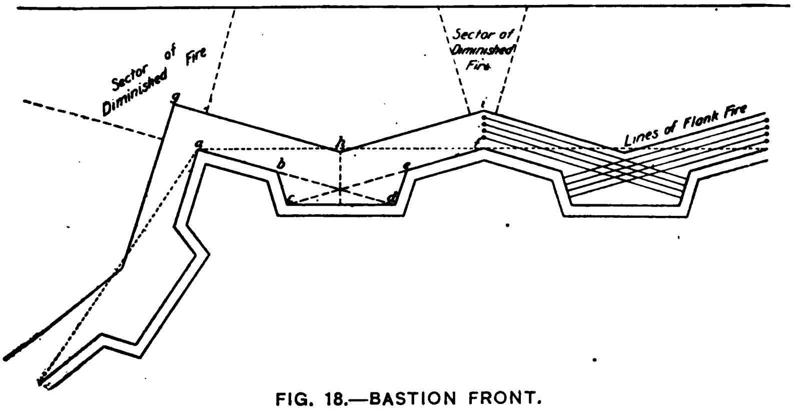


FIG. 18.—BASTION FRONT.

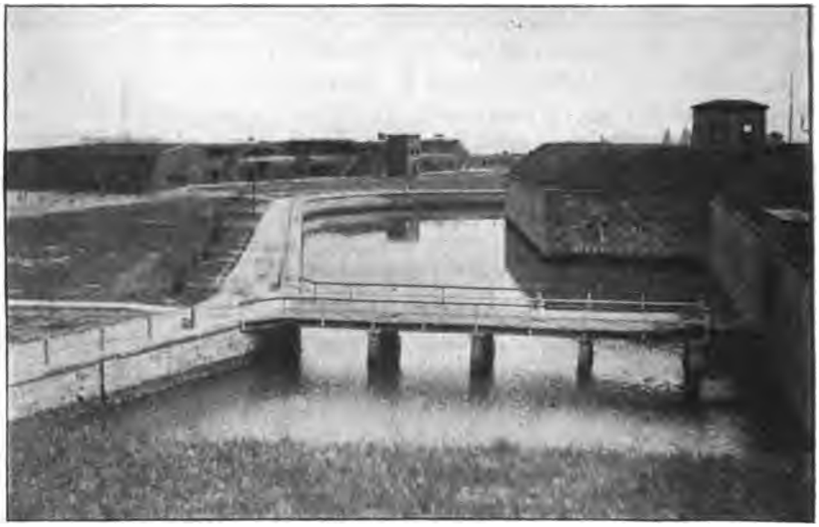


FIG. 19.—VIEW OF MOAT AT FORT MONROE, SHOWING BRIDGE AND DRAWBRIDGE; MODERN 12-INCH DISAPPEARING BATTERY IN BACKGROUND.

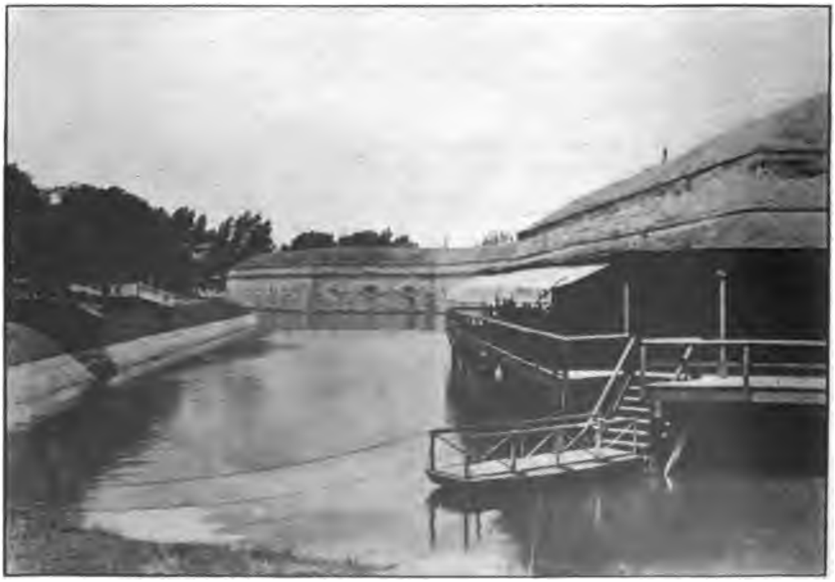


FIG. 20.—VIEW OF MOAT AT FORT MONROE, SHOWING VERANDA AROUND OFFICERS' CLUB.

In its simplest form and as shown in the figure 18, Plate IX, the bastioned trace has several important defects. It is efficient only if the proper relations be preserved between the lengths and direction of the different faces. This makes it difficult to adjust to the peculiarities of a site.

A more important defect is that it is deficient in its provision for fire directly to the front and especially along the capitals of the bastions. The curtain is the only part that fires directly to the front of the side to which it pertains and this curtain is considerably retired from the side proper which may be considered as the line joining the salients of the bastions. With the short ranged guns of the early days, this retirement of the curtain and the consequent diminution in the effective reach of its guns was of considerable importance. The faces of the bastion are slightly inclined to the side to which they pertain and are inclined in that direction which makes it the more difficult to fire in the direction of the capital of the bastion. When there are successive bastioned fronts made on the same straight line, this inclination of the faces of the bastions to the sides is a slight but not a serious difficulty; but where the bastioned fronts are made on the sides of a polygon, the difficulty becomes greater and it increases as the number of sides of the polygon becomes smaller and, therefore, the saliency of the angles more acute.

The flanks of the bastions, which are depended on for the ditch defense, are exposed to enfilading fire from the front. They must, therefore, be kept slightly lower than the faces of the bastions and must be provided with traverses to diminish the effect of the enfilading fire. The flanking fire from these flanks of the bastions is a most vital element of the ditch defense; in fact, it is practically the essential element of the bastioned system, and in order that the volume of this flank fire may be sufficient, it is essential that the flanks be sufficiently long. Consequently, the space needed for the traverses can ill be spared. The lengthening of the flanks in order to increase the volume of flank fire throws the curtain farther to the rear, and if the proper relation be maintained between the position of the rear end of the flank and the direction of the face of the next bastion the inclination of the faces of the bastions is still more unfavorably inclined, and the curtain is pushed still farther to the rear, thus increasing the difficulties discussed in the two preceding paragraphs. Incidentally the lengthening of the flanks pushes the curtain still farther away from the counterscarp in its front and makes it still more liable to being injured by cannon fire from the front.

The difficulty due to the retirement of the curtain and consequent diminution in the effectiveness of its fire was unavoidable in this system. The next most important difficulty, the deficiency of fire along the capitals of the bastions, could be avoided by building a redoubt in the reentrant angle of the counterscarp in front of the center of curtain. Such a redoubt was called a "ravelin." At first it seems to have been merely a sort of enlargement of the covered way at this point. Later it became a separate detached work with a ditch and scarp and counterscarp walls of its own (fig. 21, Pl. XI).

The ravelins of two consecutive faces, of course, bring a strong cross-fire upon the area in front of and along the capital of the bastion, and the bastions upon the space in front of the ravelin between them. However, the ditches of the ravelin exposed portions of the walls of the faces of the bastion to breaching fire, but this was partially obviated by an adjustment of the slope of the bottom of the ravelin ditch, which was raised near the junction with the main ditch so as to give partial protection to the lower part of the wall of the bastion face.

The gradually increasing range of the cannon and muskets of the defense permitted the bastion fronts to be made on a larger scale, and thus the bastions themselves and the ravelin became so large as to permit their interiors to be raised a little higher than their fronts, forming, as it were, redoubts within redoubts.

The ravelin was the first addition made to the bastioned trace. Later the redoubts in the bastion and ravelin were added. Soon the number of additions was much increased. As soon as a weakness was noted, something new was added to correct it, only in time to develop its own weaknesses, which, in turn, required correction. The complexity of fortifications, therefore, became very great until the very nomenclature became almost a science in itself. The details of some of the complicated systems developed at this time are shown on Plates XII, XIII, and XIV.

The general object of the successive outworks added was to make the besieger start his operations further and further away from the main enceinte and thus preserve the interior from gunfire as long as possible. They served also to delay the progress of the siege by providing a multiplicity of works so related that the outer ones had to be taken in turn before a real attack on an inner work could be begun. As all the outer works were so located and constructed as to be thoroughly covered by the fire of the interior, the difficulty of making a siege was much increased.

While introducing these advantages, however, several disadvantages resulted. The breaking up of the defense into such a large number of separate parts made proper unity of command difficult, if not impossible, and the resulting complexity of the system of intercommunications between the different works made the reinforcement of a threatened place exceedingly difficult. Likewise, it made the retreat from an advanced work somewhat hazardous for the garrison, and the withdrawal of the larger cannon almost impossible.

PLATE XI.

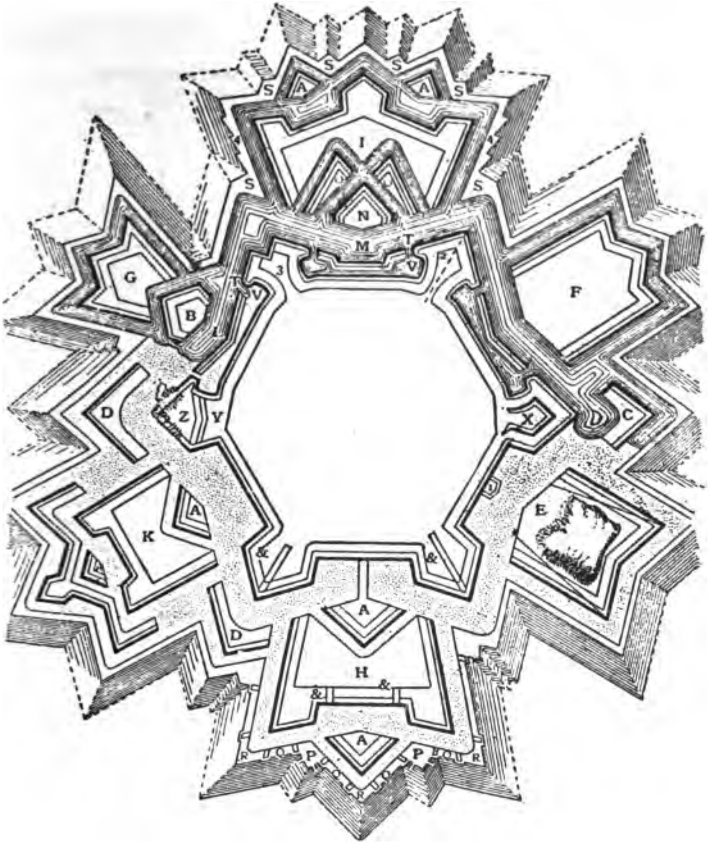


FIG. 21.

1. Flat bastion: Placed in the middle of a curtain when the lines of defense were too long for musketry range.
2. Demibastion: Used generally on the bank of a river.
3. Tenaille bastion: Used when the flanked angle is too acute; that is, less than 70°.
4. Redans: Used along the bank of a river, or when the parapet of the covered way can be taken in reverse from the front.

A, B. Ravelins.

C. Demilunes: So called from the shape of the gorge. They differ from the ravelins in being placed in front of the bastions instead of the curtains.

D. Counterguards: Used instead of demilunes, which were then going out of fashion.

E. Simple tenaille.

F. Double tenaille (see L and M).

(If the tenaille E is reduced in width toward the gorge, as shown alternatively, it is called a swallowtail. If the double tenaille is reduced as at G, it is called a bonnet de prêtre. Such works were rarely used.)

H. Hornwork: Much used for gates, etc.

I. Crown work.

K. Crowned hornwork.

L, M. New forms of tenaille. (N. B.—These are the forms which ultimately retained the name.)

N. New form of work called a demilune lunettée, the ravelin N being protected by two counterguards, O.

P. Re-entering places of arms.

Q. Traverses.

R. Salient places of arms.

S. Places of arms without traverses.

T. Orillon, to protect the flank V.

X. A double bastion or cavalier.

Y. A retrenchment with a ditch, of the breach Z.

&. Traverses to protect the terreplein of the ramparts from enfilade.

From Encyclopædia Britannica, 1910.

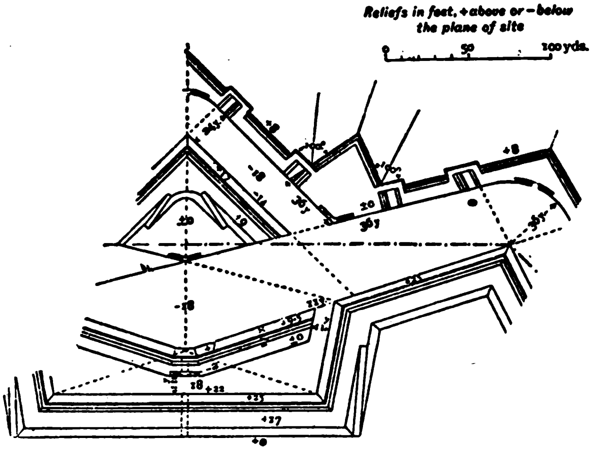


FIG. 22.—VAUBAN'S FIRST SYSTEM.

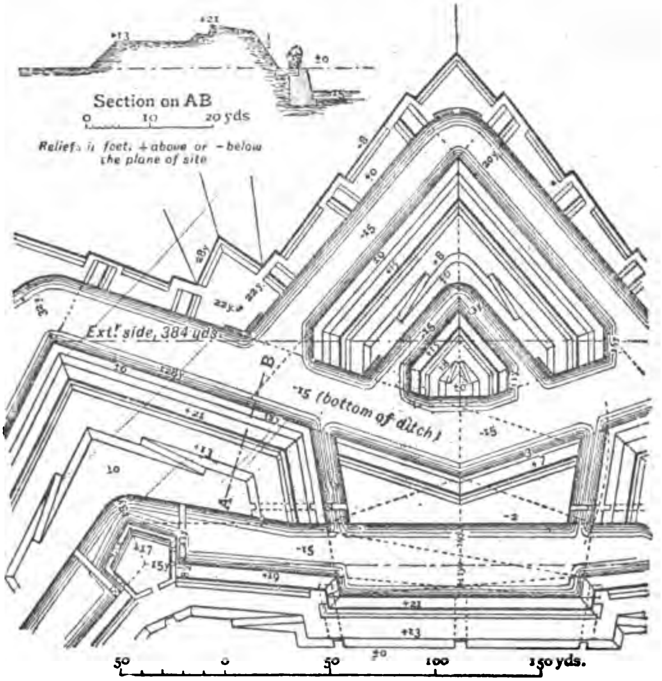


FIG. 23.—NEU-BREISACH.

From Encyclopædia Britannica, 1910.

PLATE XIII.

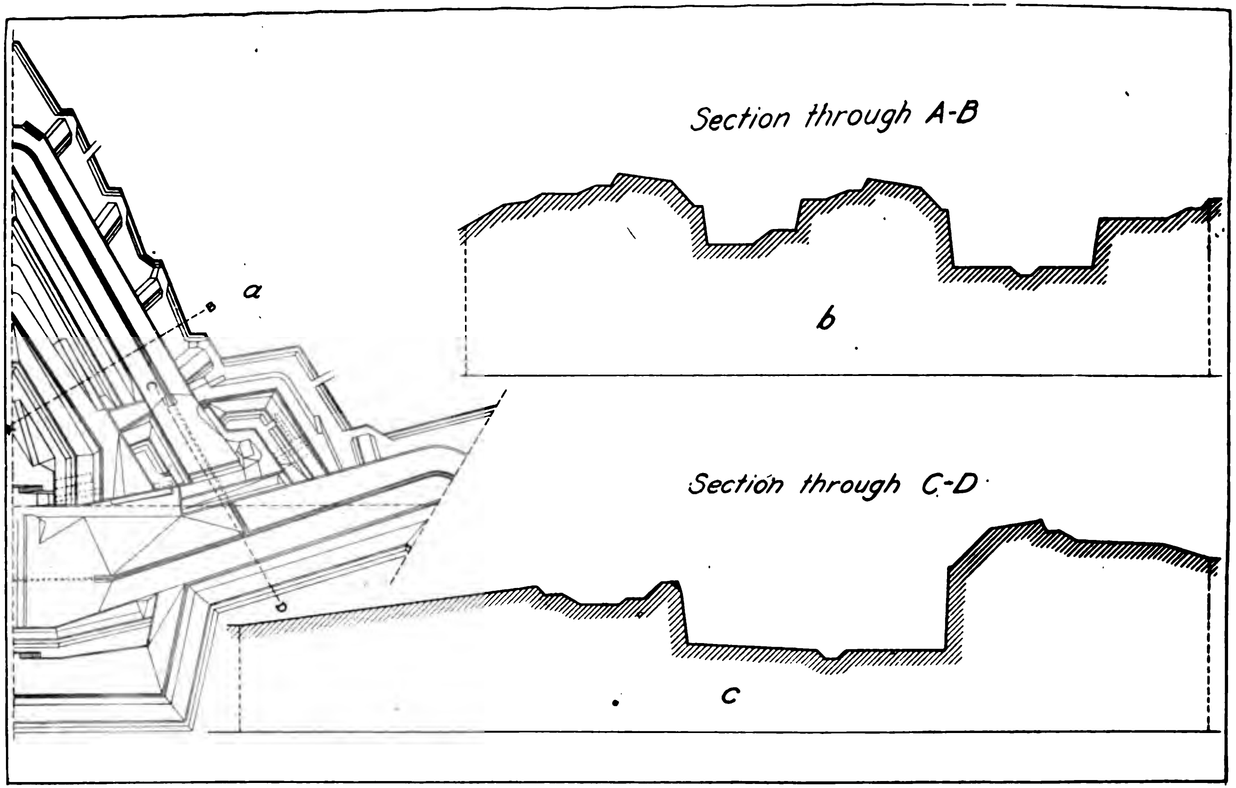


FIG. 24.—NOIZET'S FRONT.

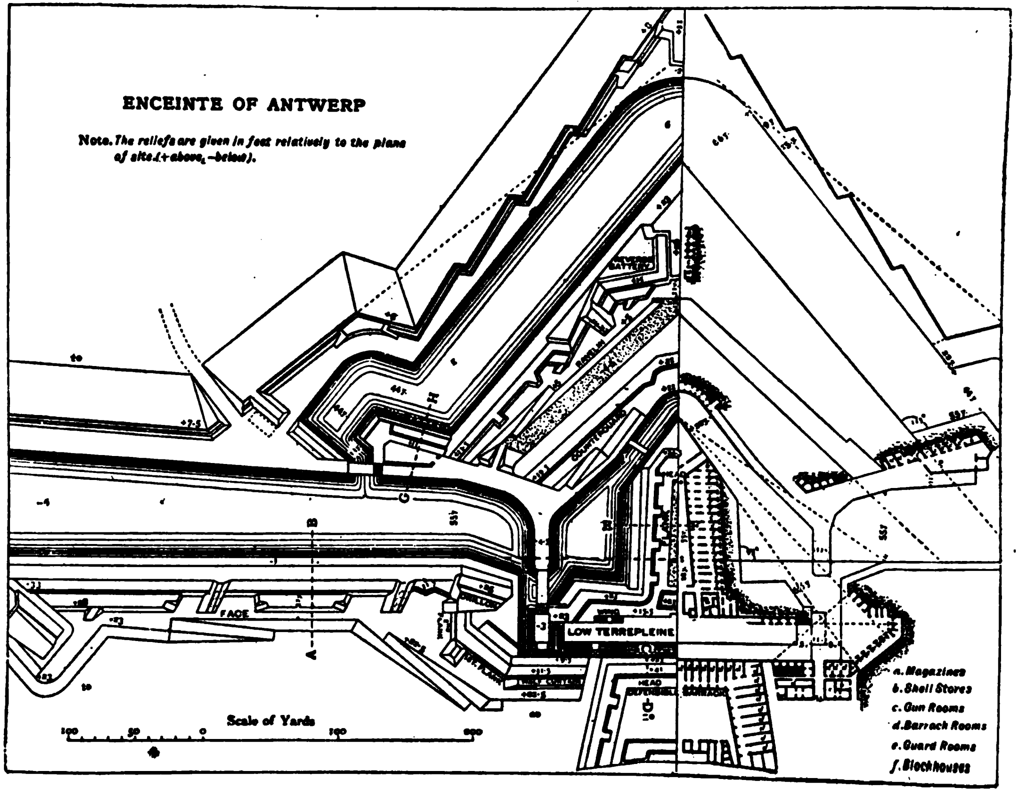


FIG. 25.

From Encyclopædia Britannica, 1910.

Theoretically, the use of a sufficient number of properly designed outworks should have delayed the progress of the siege almost indefinitely. Practically, however, such was not proved to be the case, for in nearly all cases of great complexity of outworks the sieges ended by capitulation long before the theoretical end of the siege was reached.

In fact, one important thing that seems to have been overlooked by the designers of these complicated works is the moral effect upon the garrison of being compelled to retire from and to abandon one position after another. To do this successfully and without becoming more or less demoralized required soldiers of almost unexampled morale and a commanding officer of great resolution and of unusual influence upon his command.

In a few cases, where the defenders were composed to a great extent of citizens of the town who were protecting their own families, sieges were fought out to the very end, and in a few cases the besieged held out successfully even after breaches had been opened in the main works and assault after assault had been repulsed.

In most cases, however, the soldiers during the seventeenth and eighteenth centuries were what might be called professional mercenaries, who made fighting their business. Such fighting men were to a certain extent controlled by customs which had grown up in spite of the efforts of their officers, and it seems to have been thought that when a certain amount of opposition had been opposed the defenders had done their duty. With soldiers such as these, a resistance to the very end could not be expected, and, consequently, much of the labor and money spent in the construction of the complex outworks was wasted. It is the opinion of some experts that part of this would have been better expended had more care and thought been given to perfecting the details of a simpler work.

Other Systems.

At various times and places, traces based upon other systems than the bastioned were proposed by different fortification engineers and were actually introduced into certain defensive works.

Among these was the polygonal trace (fig. 26, Pl. XV), consisting essentially of the sides of a simple polygon, with the addition of such means for flank defense and such outworks as were considered necessary.

The polygonal trace was favored by many fortification engineers because it permitted a full and direct fire to the front and thus avoided one of the serious defects of the bastioned trace. But it, in its turn, had the disadvantage of permitting no easy system of flank defense, about the only system of ditch defense possible being the caponier, to be described a few paragraphs later on.

In the early days, when the range of cannon was small and the retirement of the curtain of the bastioned system was, therefore, an important defect, the close ditch defense was of greater importance than it was later; and for this reason, the majority of fortification experts of the time preferred the bastioned system. Later, when the increasing range of cannon decreased the comparative importance of ditch defense, the retirement of the curtain of the bastioned trace became likewise a less important defect.

Another trace frequently advocated and sometimes adopted was the so-called "tenaille" trace and its modification, the "crémaillere" (figs. 27 and 28, Pl. XV). This trace was as defective as the bastioned system as regards fire directly to the front, and unless scarp galleries were used, large, dead spaces were left in the ditches. It did, however, permit a strong cross-fire along the capitals of all salients, but this was likewise true of the bastioned system after the ravelins had been provided.

In their simplest forms, of course, these and other traces differed greatly from the bastioned, but as was the case with the bastioned system, outworks and other complexities were soon added, the result being that after the outworks had been added, there was very little actual difference between any of these traces.

Into the details of these various systems and their outworks, it is considered unnecessary to go further in this book. Examples have been shown on the plates, and drawings of many others can be found in various textbooks, if any student desires to investigate the subject further.

In connection with some of the later and more complicated plans, it has been claimed by some experts, and not without apparent good reason, that at one time at least the fortification engineers semed to have lost sight of the real purpose of defensive works and to have grown to consider fortifications as an object in itself or as a sort of complicated game which only the initiated might be permitted to play.

Ditch Defense.

As will be noted in practically all of the plans, the ditches formed an essential portion of all fortification design, constituting, as they did, one of the main obstacles which the besiegers had to pass, and to pass in a position where he could receive comparatively little assistance from his friends. Some form of ditch defense, therefore, became essential.

In the earlier days of the bastioned system the ditch defense was provided by casemates in the necks of the bastions; later, by fire from the top of the flank faces of the bastions. The fire from the flank face of the bastion, however, could be seriously interfered

PLATE XV.

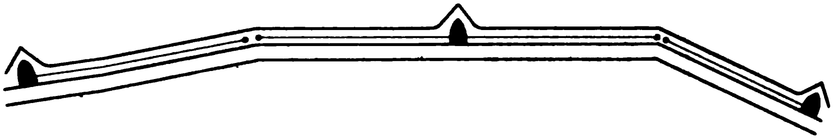


FIG. 26.—POLYGONAL FRONT.

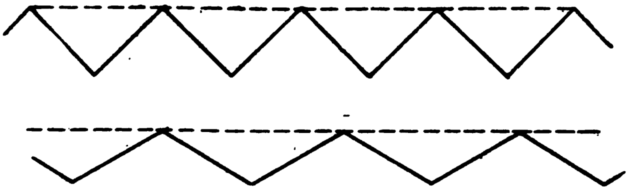


FIG. 27.—TRACES OF TENAILLE LINES.

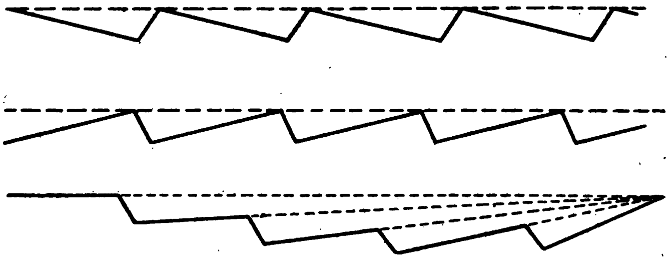


FIG. 28.—CRÉMAILLERE LINES.

PLATE XVI.

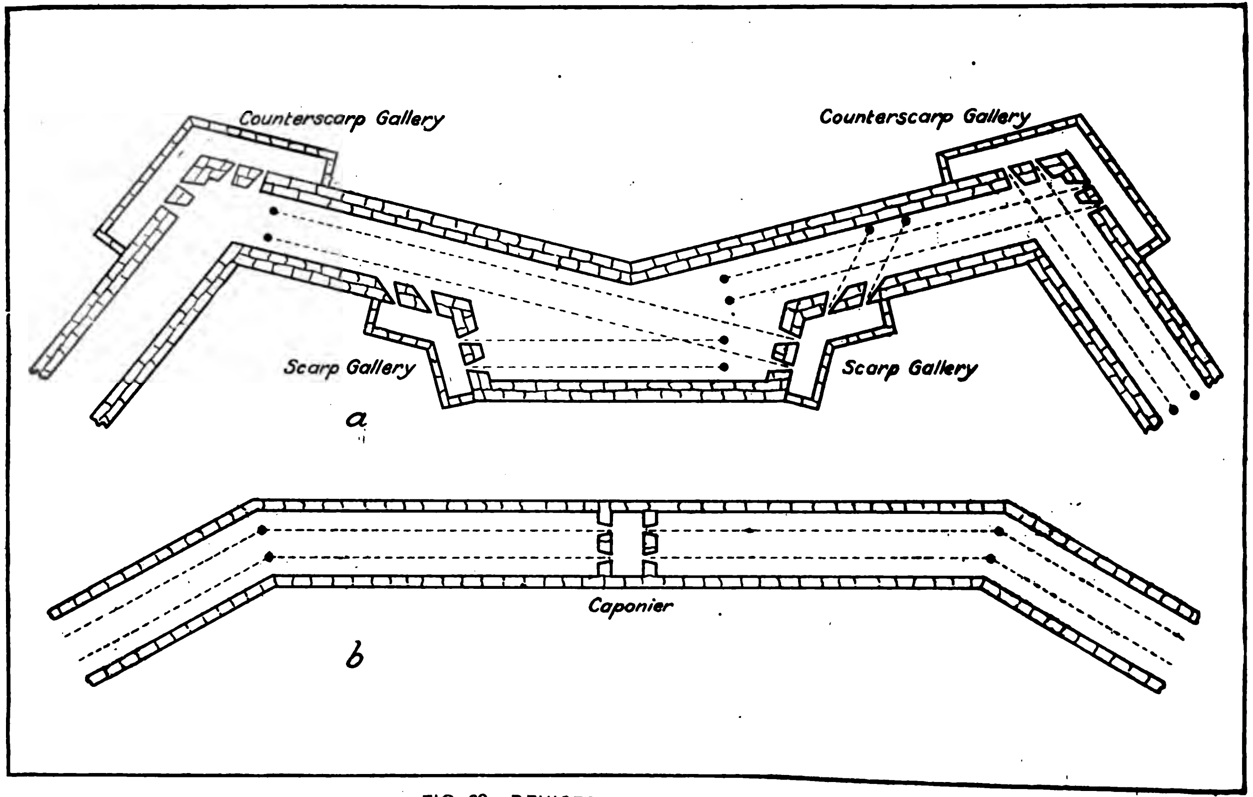


FIG. 29.—DEVICES FOR DITCH DEFENSE.

with by enfilade fire from the front and soon resort had to be had to other methods of obtaining this flanking fire.

One simple method of doing this was by scarp galleries built in the rear of the scarp wall and not far from the level of the bottom of the ditch (fig. 29, Pl. XVI). For firing from these galleries upon the ditch, loopholes for cannon or muskets were made through the scarp wall. For firing across the ditch, of course, these loopholes were not very effective, but where the galleries were made in the reentrant angles in prolongation of a considerable length of the ditch, these galleries could bring an enfilading fire upon parties working in the ditch. Scarp galleries had one great advantage—easy communication with the interior of the fort by tunnels through the ramparts, but they had the great disadvantage that in the reentrant angles of the ditch, where they were of the greatest value, they were exposed to breaching fire and to being destroyed themselves or of having their loopholes blocked by débris falling from above.

To avoid the difficulty just mentioned in scarp galleries, counterscarp galleries were introduced. These were similar galleries constructed in the rear of the counterscarp walls. The reentrant angles of the counterscarp walls, of course, occurred opposite the salients of the fort, and therefore, in positions which could not be reached by breaching fire. However, communication with the counterscarp galleries was difficult for the besieged, and these galleries were liable to be broken into by the advancing works of the besiegers before the time when they had had an opportunity to perform their functions as ditch defenses.

To avoid the difficulties met with in attempting to provide ditch defense by either scarp or counterscarp galleries there was introduced what was known as the caponier. The caponier is a low work built out into or across the ditch and entered by a tunnel from the main work. In the side walls of the caponier, and therefore pointing in either direction along the ditch, loopholes were provided for enfilading the ditch by cannon or musketry fire. The caponier being low was not very liable to be struck by a breaching fire; furthermore, it was situated so far away from the walls that the loopholes could not be blocked up by débris falling from above. It has, therefore, been considered by many experts as the most efficient form of ditch defense. Its original use was in one of the sides of a polygonal trace, and it is really about the only form of ditch defense easily adaptable to that trace.

SIEGE WORKS.

Even after the introduction of cannon, the first step in attacking a city was, as it has previously been, the blockade. The next, to provide out of range of the guns of the defense, fortified camps for the protection of the besiegers and their siege material against sorties from the garrison. This being done and the siege cannon having been brought up, the besiegers were ready to begin the siege in earnest.

The most important element of all sieges is the cannon of the besiegers, but it is to be assumed that the defense will possess cannon having as great a range as those of the besiegers. Consequently, if the besiegers' cannon are to be kept out of range of the guns of the defense, they will be so far away that they can do nothing themselves.

Therefore, before the besiegers can expect to do any harm with their guns, these guns must be brought so close to the walls as to be well within range of the guns on the walls. To protect them from gun fire from the walls they must, therefore, be protected by some kind of earthworks.

In the early days, not only were cannon of small range, but the penetration of their projectiles was poor, and gabions filled with earth apparently formed a sufficient protection for the besiegers' guns (figs. 30, 31, and 32, Pls. XVII, XVIII, and XIX).

Under cover of night and provided they were not hindered by sorties, it was, of course, possible for the besiegers to push forward and before day to build an earthwork sufficient to protect a few siege guns which could either be pushed forward that night or the next.

The fire of the siege guns was, of couse, too slow to furnish a sufficient protection against an infantry sortie and consequently infantry redoubts had to be constructed near all siege batteries.

These advance batteries and redoubts having been built well within the range of fire from the walls were, of course, to a certain extent cut off during the day time from communication with the rear. In order to preserve this communication, trenches were dug extending from the advance batteries and redoubts back to the besiegers' works, which were out of range of the defense. If these trenches were built directly toward the works, they would, of course, be subject to enfilade fire; and to avoid this, they were built obliquely, that is, the trenches formed a series of zigzags (fig. 33, Pl. XX).

The first guns installed by the besiegers would serve to keep down to a considerable extent the fire of the besieged, and under their protection and those of the first redoubts, other guns could be brought up and could be installed even closer to the besieged (fig. 34, Pl. XXI).

In the sixteenth century this process of alternate advancing could

PLATE XIX.

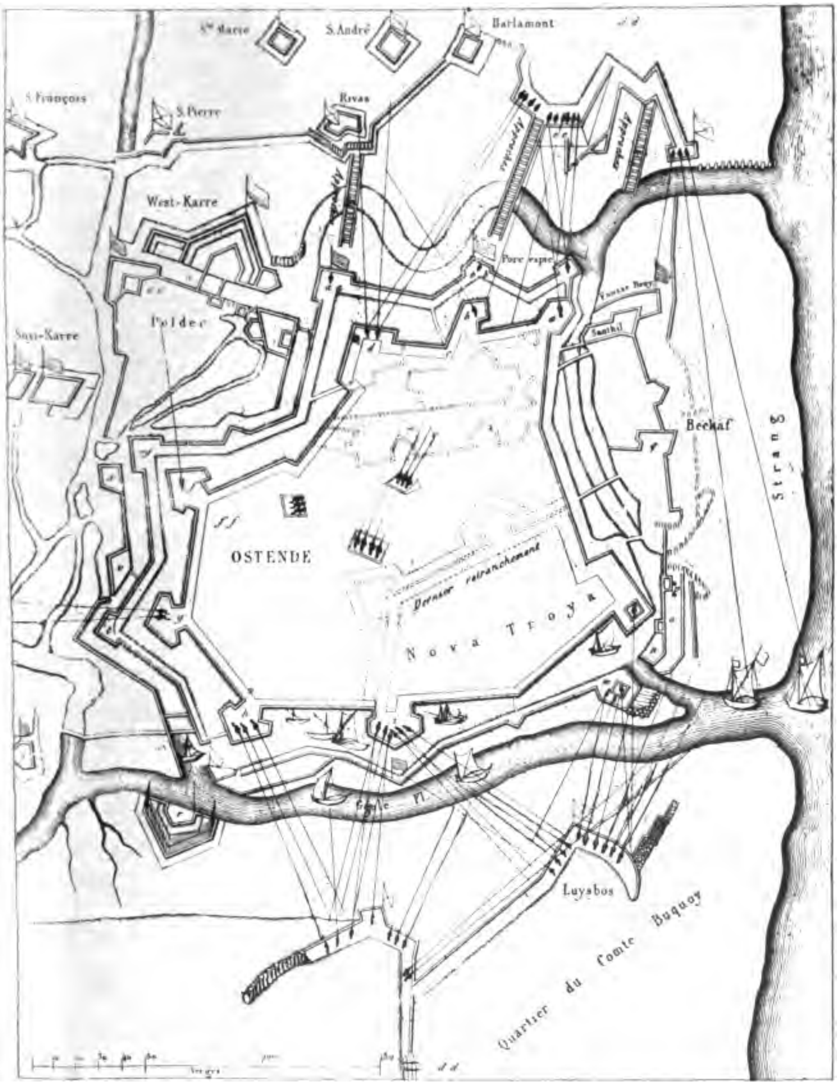


FIG. 32.—SIEGE OF OSTEND, 1601.

PLATE XX.

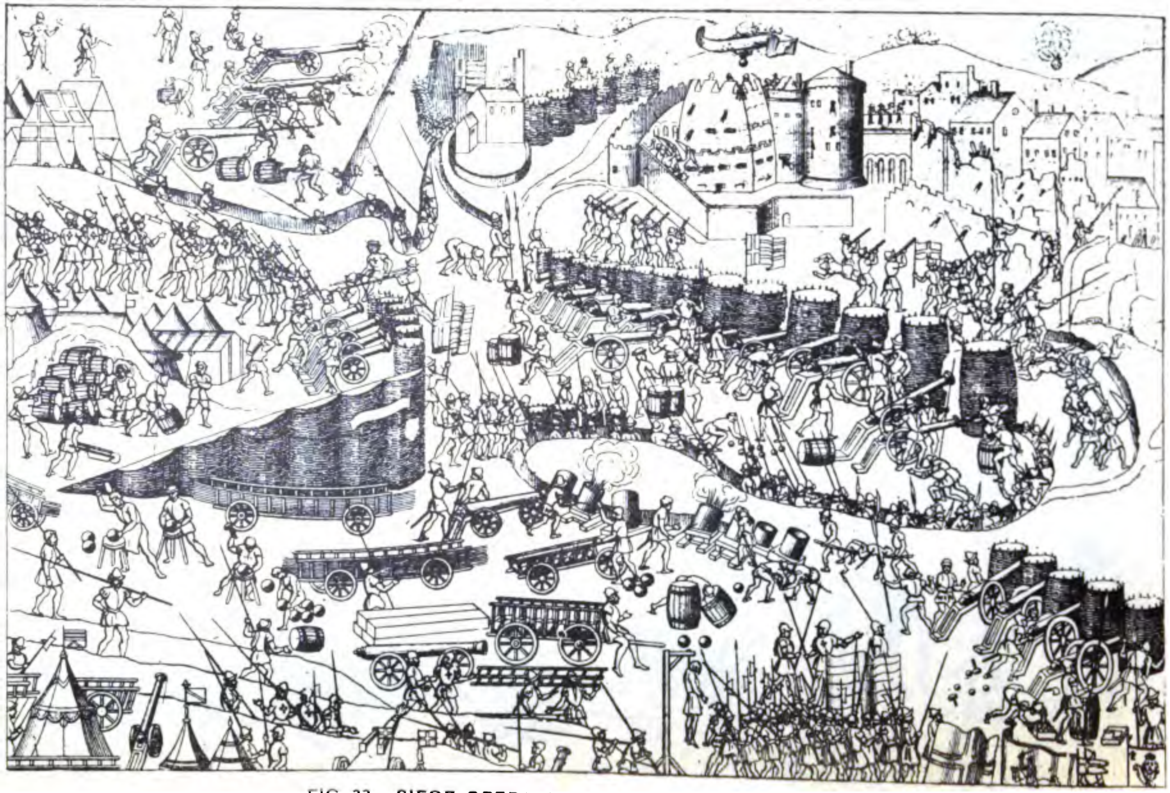


FIG. 33.—SIEGE OPERATIONS—SIXTEENTH CENTURY.

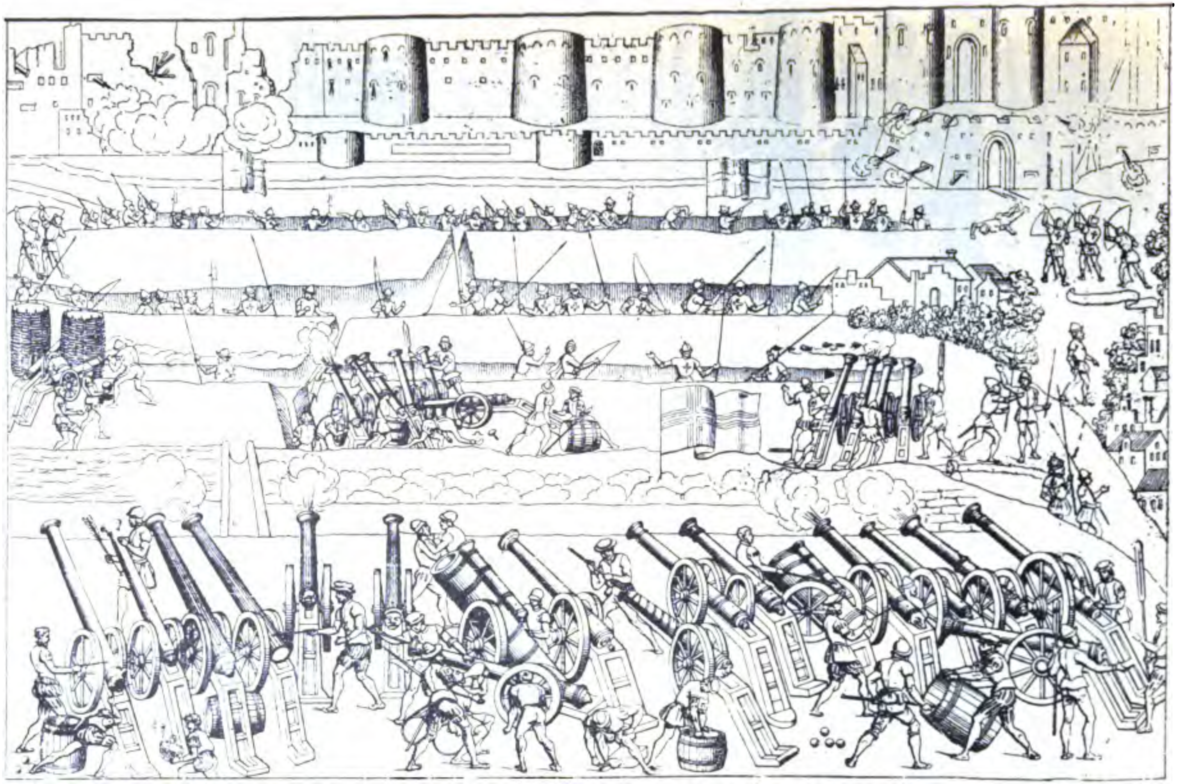
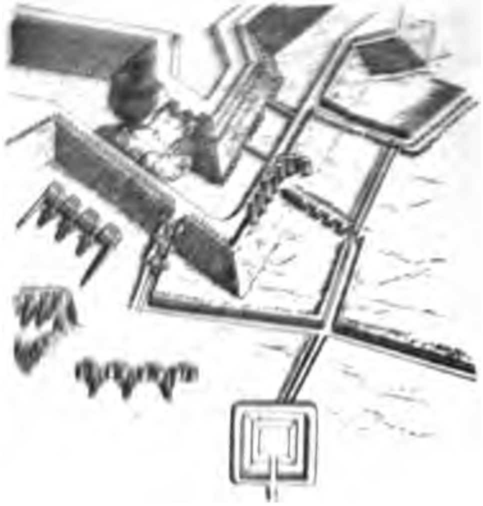
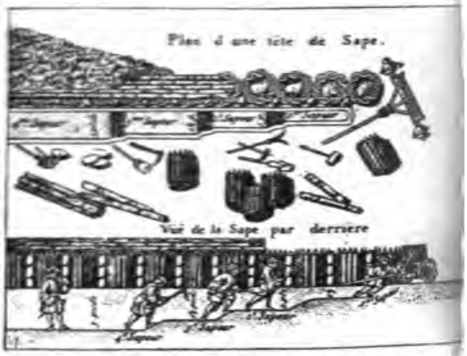


FIG. 34.—SIEGE OPERATIONS—SIXTEENTH CENTURY.



[illegible] WORKS OF THE SEVENTEENTH CENTURY



Plan d une tete de Sape.
Vuë de la Sape par derriere

FIG. 36.—SAPPING (VAUBAN).

[illegible]

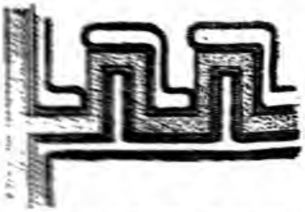


FIG. [illegible] DIRECT ADVANCE BY DOUBLE SAP be continued practically until the crest of the glacis had been reached, for the effective range of cannon at the end of the sixteenth century did not exceed about 400 yards, while the effective range of musketry was from 180 to 200 yards only. Consequently, by working at night, it would be possible, without extreme loss, for the siege works above mentioned to be constructed without resort to sapping.

When the besiegers' batteries had once been established on the crest of the glacis, the next step was, of course, to select an apparently weak portion of the wall and to fire the cannon at it until a breach had been made. In the meantime, the engineers would be busy tunneling down until they were in the rear of the bottom of the counterscarp wall. An opening in this wall would be broken through and then an attempt would be made to build a trench across the ditch to the foot of the breach, after which, of course, an assault could be attempted, the fire of the defense during the formation of the assaulting party being kept down by the fire of the besiegers' guns on all parts of the work from which fire could interfere with the assault (fig. 35, Pl. XXII).

The system of siege approaches thus roughly outlined seems to have originated and to have been developed at first by Italian engineers during the sixteenth century, but it did not become regularly systematized until much later.

As long as the guns were of no greater range than those mentioned and the siege work could be started comparatively close to the walls, the system above referred to was feasible; but as the range of the defenders' guns increased, it became necessary to start the besiegers' works farther away and to exercise more care in the construction of the siege works.

By the latter part of the seventeenth century, the effective range of cannon had increased to about 600 or 700 yards, and they could do some little damage at 1,000 yards. Consequently, a more systemized method of siege works was necessary, and such a system was developed by the French engineers working for King Louis XIV in the latter half of the seventeenth century.

Of these engineers the most famous was Vauban. In fact, Vauban's greatest claim to fame should rest upon the system of siege works which he developed and carried out successfully in practice no fewer than 40 times. Strange to say, however, this master of siegecraft seems to be better known in history by a modification of the bastioned trace that he developed. Vauban did indeed supervise the construction, or the reconstruction, of the fortifications of many of the frontier towns of France, but his greatest work was in showing how it was possible to systematically capture fortified places.

The early stages of Vauban's system of siege work resembled that which had been used before his day and which has been described

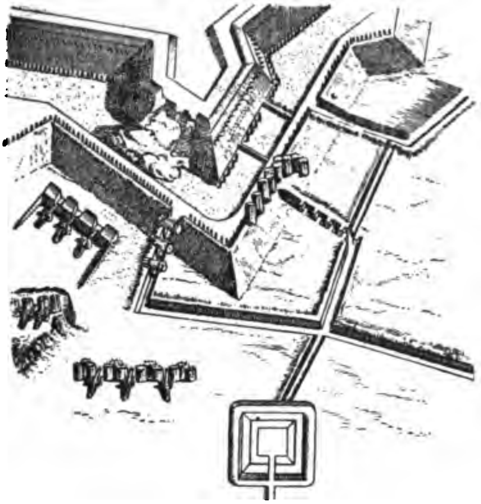


FIG. 35.—SIEGE WORKS OF THE SEVENTEENTH CENTURY.

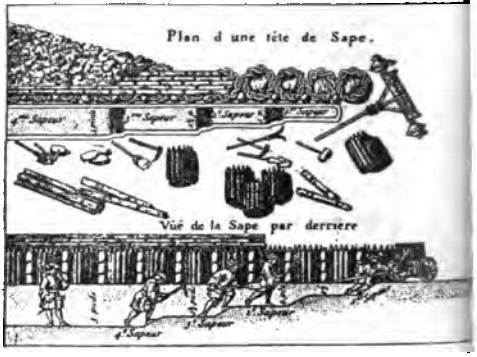


FIG. 36.—SAPPING (VAUBAN).

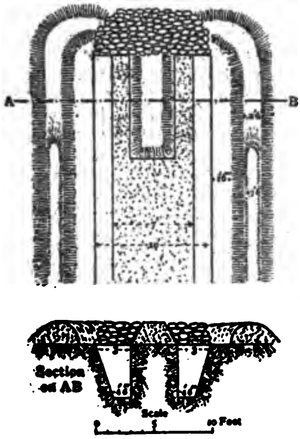


FIG. 37.—DOUBLE SAP.

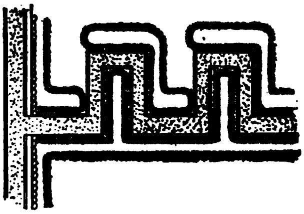


FIG. 38.—DIRECT ADVANCE BY DOUBLE SAP.

Figures from Encyclopædia Britannica—1910.

be continued practically until the crest of the glacis had been reached, for the effective range of cannon at the end of the sixteenth century did not exceed about 400 yards, while the effective range of musketry was from 180 to 200 yards only. Consequently, by working at night, it would be possible, without extreme loss, for the siege works above mentioned to be constructed without resort to sapping.

When the besiegers' batteries had once been established on the crest of the glacis, the next step was, of course, to select an apparently weak portion of the wall and to fire the cannon at it until a breach had been made. In the meantime, the engineers would be busy tunneling down until they were in the rear of the bottom of the counterscarp wall. An opening in this wall would be broken through and then an attempt would be made to build a trench across the ditch to the foot of the breach, after which, of course, an assault could be attempted, the fire of the defense during the formation of the assaulting party being kept down by the fire of the besiegers' guns on all parts of the work from which fire could interfere with the assault (fig. 35, Pl. XXII).

The system of siege approaches thus roughly outlined seems to have originated and to have been developed at first by Italian engineers during the sixteenth century, but it did not become regularly systematized until much later.

As long as the guns were of no greater range than those mentioned and the siege work could be started comparatively close to the walls, the system above referred to was feasible; but as the range of the defenders' guns increased, it became necessary to start the besiegers' works farther away and to exercise more care in the construction of the siege works.

By the latter part of the seventeenth century, the effective range of cannon had increased to about 600 or 700 yards, and they could do some little damage at 1,000 yards. Consequently, a more systemized method of siege works was necessary, and such a system was developed by the French engineers working for King Louis XIV in the latter half of the seventeenth century.

Of these engineers the most famous was Vauban. In fact, Vauban's greatest claim to fame should rest upon the system of siege works which he developed and carried out successfully in practice no fewer than 40 times. Strange to say, however, this master of siegecraft seems to be better known in history by a modification of the bastioned trace that he developed. Vauban did indeed supervise the construction, or the reconstruction, of the fortifications of many of the frontier towns of France, but his greatest work was in showing how it was possible to systematically capture fortified places.

The early stages of Vauban's system of siege work resembled that which had been used before his day and which has been described

above, except, of course, that due to the greater range of cannon, the work had to be started a little farther from the enciente. Apparently his batteries were first emplaced at about 1,000 yards from the walls, not so much with the idea that from this distance they could do very much actual damage, but largely to reduce the morale of the defenders.

At about this distance from the enciente he would start his zigzag approaches (fig. 39, Pl. XXIII). He always did this in several places so as to leave the defenders guessing as to which was the principal point of attack. These approaches he continued until he was about 600 or 700 yards from the walls.

To push these zigzags farther would leave the men in them so far in advance of any large bodies of their friends as to be subject to sudden sorties. Consequently, at about this distance from the work, Vauban introduced his first big improvement. That is, he connected the various zigzags by a trench approximately parallel to the enciente and known as the "first parallel."

This first parallel was made quite deep and wide, so it could be utilized as a communication between the different zigzags, and also as a storage place for siege material needed for further advances. The front of this parallel was fitted as an infantry parapet, and, when necessary, was manned by infantry to repel sorties and to protect the men in their farther advances by keeping up an infantry fire upon any of the defenders' work within range.

In connection with this first parallel, and usually just in front of it, Vauban constructed his new siege batteries. Great care was used in building these batteries, and since by this time the particular target for each siege gun or battery had been selected, it was possible to finish the front of these emplacements with narrow slots or embrasures through which the guns would fire, and which were so narrow as to give great protection to the guns themselves.

Under the protection of these siege batteries and of the infantry in the first parallel, the zigzags would again be started and would be pushed forward for another 200 yards or so, when another parallel called a "second parallel" would be constructed. Like the first parallel, this second parallel would be finished for the use of infantry, and in connection with it still more advanced positions for the artillery would be put up.

Up to this stage, the siege work was usually done at night by what is called "flying trench" work. A few skirmishers or outposts would first be sent forward at nightfall to give warning of a sortie. When these were in position and under their protection, the working parties would start out, each man carrying his weapons, his digging tools, and two gabions. They would march as quietly as possible until they reached the line already taped out by the engineers. Each man would then place his gabion on the line immediately in front of the

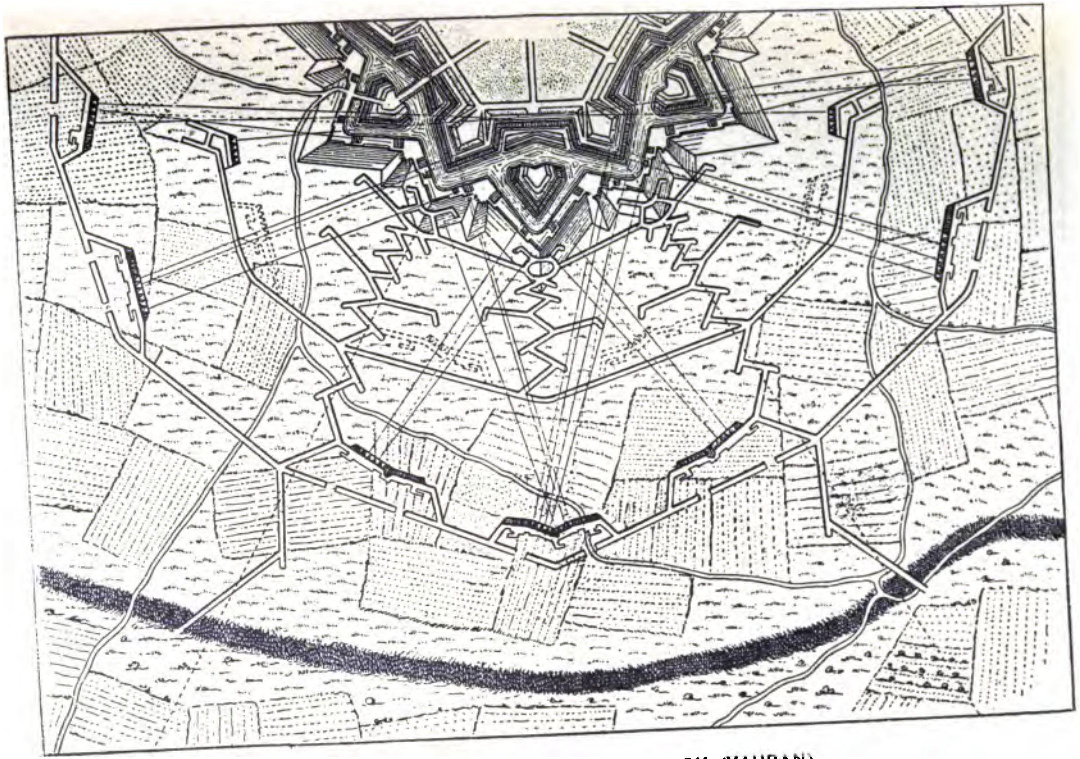


FIG. 39.—REGULAR ATTACK (VAUBAN).

From Encyclopædia Britannica, 1910.

tape, put his gun down a little distance to the rear, and then would begin to dig as quietly as possible. By daybreak he should have been able to dig a trench some 3 or 4 feet deep, throwing the earth into and in front of his gabions, and thus forming a parapet sufficient to give considerable cover to men in the trench. Just before daybreak, the men who worked at night would be relieved by others who would continue the work by day under cover of the partial protection afforded by the night work.

Sapping.

If the defenders were at all active, the extension of the flying trench work much beyond the second parallel was usually impracticable, and resort had to be had to sapping. Sapping required specially instructed men and was considered as the special province of the sappers or engineers (fig. 36, Pl. XXII). At the very head of the sap a man worked on his knees, digging a narrow shallow trench and throwing the earth into a gabion a little to his front and on the side toward the enemy. From time to time a new gabion would be passed to him which he would push forward into its place by means of hooks, and which in turn he would try to fill.

As the first sapper pushed forward in this manner, a second one, as close behind him as possible, was deepening and widening the trench which the first one had made, throwing the earth on the outside of the gabion already in place. Behind him in turn would be other sappers, widening and deepening the trench.

Of course, the progress of the sap or trench depended entirely upon the progress made by the first man. He was, therefore, relieved frequently and every assistance possible was given him by the men in the rear, in bringing him material and helping him push it forward. Incidentally also, he was sometimes protected in front by what is known as a sap roller. This was a large gabion-like affair composed of two gabions, one about 5 feet in diameter and the other about 2 feet in diameter, so placed that the axes of the two gabions were in the same line and the space between the gabions was filled with brush or earth. Sometimes also, the first sapper had the protection of what is known as a sap shield, a small metal shield placed on the berm between the gabion and the trench. Sometimes this was merely leaned against the gabions, but sometimes it was provided with rollers so it could more easily be pushed forward.

In due time these zigzag saps would have been pushed so far ahead of the second parallel as to require the protection of another parallel known as the third parallel, which would here be built connecting the various approaches. (Figs. 39 and 40, Pls. XXIII and XXIV.) In Vauban's day it was usually possible to build this third parallel at about the foot of the glacis, but sometimes it had to be built farther away from the works, in which case it might be necessary to resort to a fourth parallel or to other shorter parallels.

As the approaches came closer to the work, a resort to the zigzag method of approach made the trenches unduly long in comparison with the distance forward which was gained by them, and, consequently, when the glacis was reached, recourse was usually had to what is known as a double sap. The double sap (see figs. 37 and 38, Pl. XXII) was advanced almost directly toward the work. It was started as two parallel, narrow saps dug by men a few feet apart, throwing the earth away from each other. These saps were subsequently widened, connected, and deepened by the men behind. The workers in this ditch were protected by a pile of sand bags in front. Each sand bag, as it was about to be undermined, would be picked up and pushed over the top of the pile of sand bags by forks or rakes built for the purpose. To push a sap of this character very far would render it liable to enfilade, so it was broken by frequent traverses.

In this way the top of the glacis would gradually be approached and there large redoubts would be built. Later these various redoubts would be connected by saps running along the crest of the glacis until finally the besiegers had control of considerable lengths of this crest. In these redoubts or along other portions of this sap would be concentrated the siege batteries to bring breeching fire upon the portions of the scarp wall selected for attack.

Of course, by this time the guns of the defense must have been practically silenced, so that the besiegers' guns had but little to do except to make the breaches. In the meantime the sappers would have tunneled down in the rear of the counterscarp wall, would have broken through into the ditch at several places, and would have started their saps or trenches across the ditch toward the breaches which had already been made, or which were in progress. Where the ditch was wet, instead of tunneling down and crossing the ditch by sapping, fascines or gabions loaded with stone would be thrown into the moat until they showed above the surface of the water, when earth would be thrown on top and the sapping started again across this.

As has been stated, this system of siege approaches was perfected by Vauban, and was used without change in principle and with but little change in detail for many years. It was extensively used during the siege of Sebastopol in the Crimean War, during the sieges in our Civil War, by the Germans in the Franco-Prussian War at Strassburg and Belfort, and much later by the Japanese at Port Arthur.

Of course, all siege works had to be adapted to the circumstances of the case, thus where the ground was rock and could not be dug

PLATE XXIV.

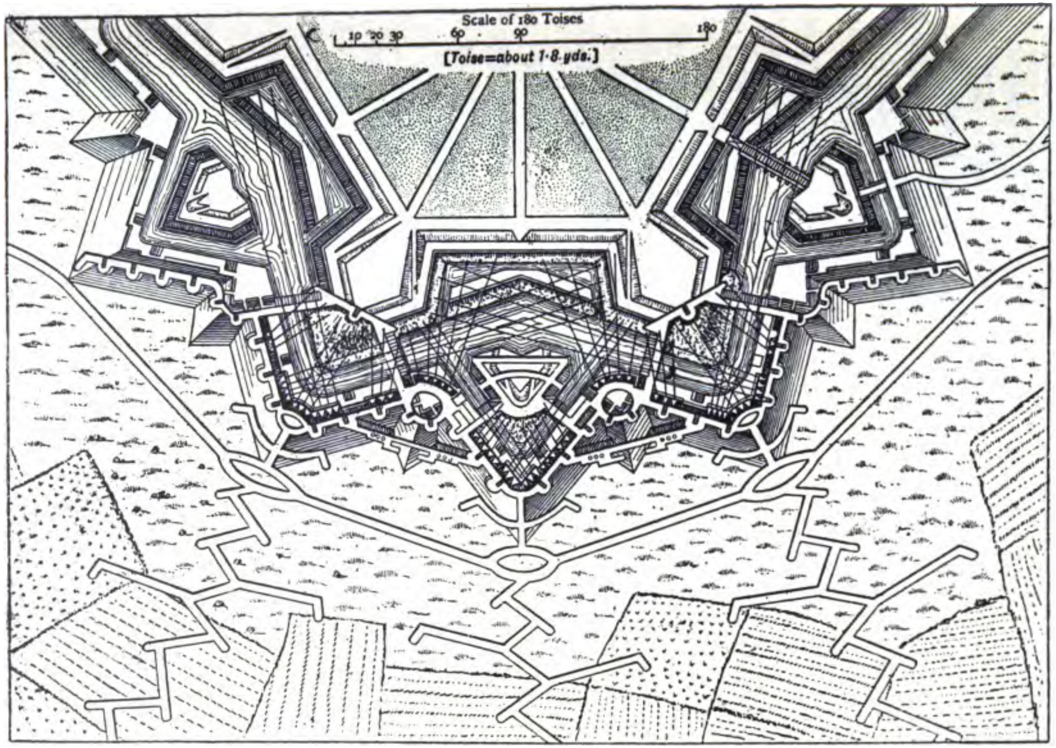


FIG. 40.—LATER STAGES OF THE ATTACK (VAUBAN).

From Encyclopædia Britannica, 1910.

into, it was necessary to resort to sand bags of earth brought in from the rear.

At the siege of Strassburg, one of the wet ditches was crossed by means of a bridge made of kegs secured at a neighboring brewery. This bridge was built at night. The kegs were slowly rolled down into the water, fitted with saddles and fastened together. They were then hauled out by a cable which had been carried over by a man swimming. The bridge was completed in about two hours, and was not discovered until a lodgment had been effected on the outworks to which the bridge lead. This bridge, however, though somewhat notable, was readily struck by shells and had later to be replaced by an earthen dam.

Defense Against Siege.

To stand any chance of holding out, the defenders of a besieged town had to keep very busy. All damage done had to be rapidly repaired to the extent possible, usually by working at night. Constant gunfire must be maintained on the enemy's works, especially his siege batteries and the heads of his saps. The advance of the enemy's trenches had to be delayed by sorties, and in general, every possible attempt had to be made to interfere with the besiegers' operations.

Siege Mortars.

Apparently the first really successful cannon were mortars, rather than direct-fire guns; that is, they were intended for high-angle fire, throwing large stones into a besieged place for the purpose of doing general damage, rather than for injuring any particular part of the defense. Later, however, the tendency seemed to develop of relying on direct-fire guns, both defensively and offensively, during a siege, probably because of their greater accuracy of fire and of the possibility of seeing exactly what damage they had done.

In the latter part of the seventeenth century, however, it began to be seen that the defenders' direct-fire guns, when visible, were certain to be ultimately dismounted or silenced. Consequently, recourse was again had to mortars that could be fired from concealed batteries which could hardly ever be silenced. The fire from these mortars was, of course quite erratic, but it was sufficient to seriously interfere with siege operations.

In some of the permanent fortifications built about the towns, especially in Holland, mortar batteries were a prominent feature.

Similarly, the use of mortars or howitzers by the besiegers for general bombarding purposes became quite common with the idea principally of affecting the morale of the besieged. This custom has continued ever since; it was extensively used during our own Civil War and by the Germans in the recent war.

above, except, of course, that due to the greater range of cannon, the work had to be started a little farther from the enciente. Apparently his batteries were first emplaced at about 1,000 yards from the walls, not so much with the idea that from this distance they could do very much actual damage, but largely to reduce the morale of the defenders.

At about this distance from the enciente he would start his zigzag approaches (fig. 39, Pl. XXIII). He always did this in several places so as to leave the defenders guessing as to which was the principal point of attack. These approaches he continued until he was about 600 or 700 yards from the walls.

To push these zigzags farther would leave the men in them so far in advance of any large bodies of their friends as to be subject to sudden sorties. Consequently, at about this distance from the work, Vauban introduced his first big improvement. That is, he connected the various zigzags by a trench approximately parallel to the enciente and known as the "first parallel."

This first parallel was made quite deep and wide, so it could be utilized as a communication between the different zigzags, and also as a storage place for siege material needed for further advances. The front of this parallel was fitted as an infantry parapet, and, when necessary, was manned by infantry to repel sorties and to protect the men in their farther advances by keeping up an infantry fire upon any of the defenders' work within range.

In connection with this first parallel, and usually just in front of it, Vauban constructed his new siege batteries. Great care was used in building these batteries, and since by this time the particular target for each siege gun or battery had been selected, it was possible to finish the front of these emplacements with narrow slots or embrasures through which the guns would fire, and which were so narrow as to give great protection to the guns themselves.

Under the protection of these siege batteries and of the infantry in the first parallel, the zigzags would again be started and would be pushed forward for another 200 yards or so, when another parallel called a "second parallel" would be constructed. Like the first parallel, this second parallel would be finished for the use of infantry, and in connection with it still more advanced positions for the artillery would be put up.

Up to this stage, the siege work was usually done at night by what is called "flying trench" work. A few skirmishers or outposts would first be sent forward at nightfall to give warning of a sortie. When these were in position and under their protection, the working parties would start out, each man carrying his weapons, his digging tools, and two gabions. They would march as quietly as possible until they reached the line already taped out by the engineers. Each man would then place his gabion on the line immediately in front of the

strong enough to make a crater, would yet break through into the enemy's galleries and fill them for a long time with the fumes of the explosives.

As a general rule, mining would be resorted to by the besiegers as the siegeworks came close to the enemy's works and the advance of the siegeworks became consequently quite slow.

To prevent this, it was not unusual in connection with the construction of permanent fortifications to build out from the counterscarp galleries long tunnels to the front with branches or side tunnels at intervals. Should mining be attempted, these tunnels provided convenient places from which to start countermines, and before the countermining was attempted, they formed convenient listening posts to detect the actions of the enemy should he attempt mining.

Mine operations at best are exceedingly slow and as a rule have been resorted to only in connection with the siege of places obstinately held. In nearly all cases where mining has been resorted to by the besiegers, countermining has been used by the defenders. In connection with the latter, it should be noted that if mining operations had been extensively used and there had been many explosions underground, the soil would become so impregnated with poisonous gases as to make the continuance of mining operations practically impossible.

SEACOAST DEFENSES.

Throughout this period there was a steady growth in the value of sea-borne commerce. The age of maritime discoveries and the rapid improvement in the size and sailing qualities of ships brought distant lands within commercial reach. Colonies were established and grew up rapidly in the recently discovered countries, and commerce with these colonies became important. For the protection of commerce or for preying upon an enemy commerce, there was a rapid naval development, and toward the end of this period the naval control of the sea became an important factor in warfare.

The naval vessels of the day were designed primarily to fight other vessels and not for attacking seacoast forts. They were propelled entirely by sails and for free maneuvering sea room was necessary. In the open sea they were quite safe, but they dared venture near the shore only in good weather or when there was a harbor or roadstead in which they might take refuge in case of a sudden storm. Consequently, harbors were much more essential to them than they are now to vessels propelled by steam, and all landing operations had to be conducted in or in the near vicinity of a harbor.

Consequently the commercial ports of the enemy became important points of attack and such ports had to be provided with defenses against such naval attack.

above, except, of course, that due to the greater range of cannon, the work had to be started a little farther from the enciente. Apparently his batteries were first emplaced at about 1,000 yards from the walls, not so much with the idea that from this distance they could do very much actual damage, but largely to reduce the morale of the defenders.

At about this distance from the enciente he would start his zigzag approaches (fig. 39, Pl. XXIII). He always did this in several places so as to leave the defenders guessing as to which was the principal point of attack. These approaches he continued until he was about 600 or 700 yards from the walls.

To push these zigzags farther would leave the men in them so far in advance of any large bodies of their friends as to be subject to sudden sorties. Consequently, at about this distance from the work, Vauban introduced his first big improvement. That is, he connected the various zigzags by a trench approximately parallel to the enciente and known as the "first parallel."

This first parallel was made quite deep and wide, so it could be utilized as a communication between the different zigzags, and also as a storage place for siege material needed for further advances. The front of this parallel was fitted as an infantry parapet, and, when necessary, was manned by infantry to repel sorties and to protect the men in their farther advances by keeping up an infantry fire upon any of the defenders' work within range.

In connection with this first parallel, and usually just in front of it, Vauban constructed his new siege batteries. Great care was used in building these batteries, and since by this time the particular target for each siege gun or battery had been selected, it was possible to finish the front of these emplacements with narrow slots or embrasures through which the guns would fire, and which were so narrow as to give great protection to the guns themselves.

Under the protection of these siege batteries and of the infantry in the first parallel, the zigzags would again be started and would be pushed forward for another 200 yards or so, when another parallel called a "second parallel" would be constructed. Like the first parallel, this second parallel would be finished for the use of infantry, and in connection with it still more advanced positions for the artillery would be put up.

Up to this stage, the siege work was usually done at night by what is called "flying trench" work. A few skirmishers or outposts would first be sent forward at nightfall to give warning of a sortie. When these were in position and under their protection, the working parties would start out, each man carrying his weapons, his digging tools, and two gabions. They would march as quietly as possible until they reached the line already taped out by the engineers. Each man would then place his gabion on the line immediately in front of the

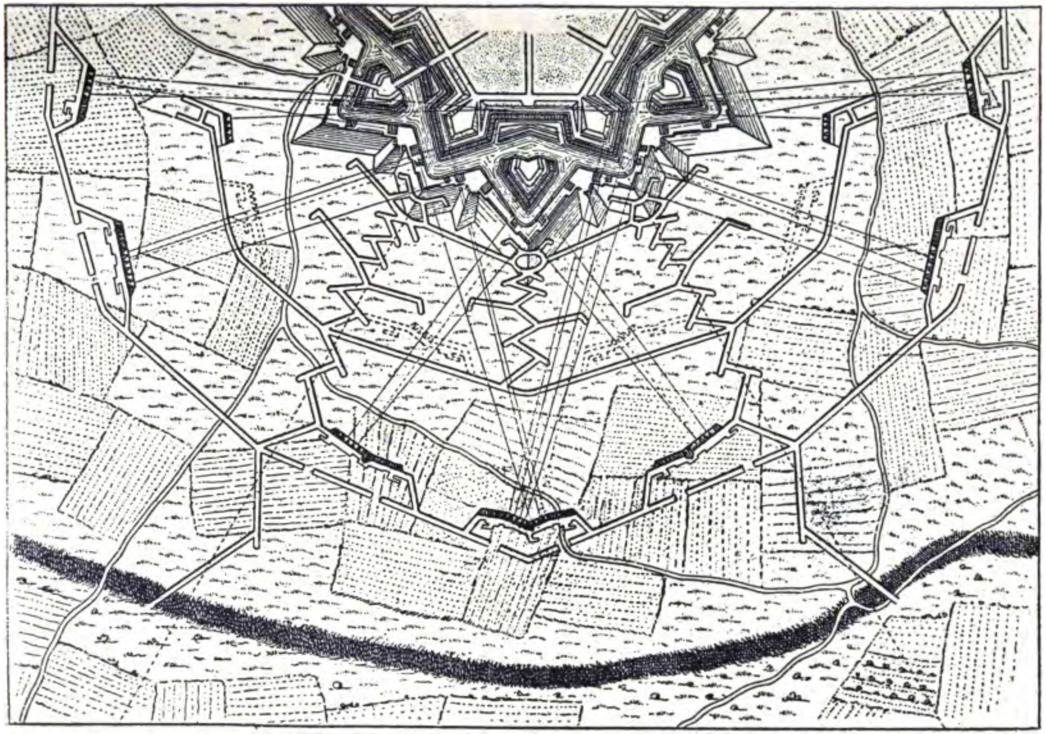


FIG. 39.—REGULAR ATTACK (VAUBAN).

From Encyclopædia Britannica, 1910.

tape, put his gun down a little distance to the rear, and then would begin to dig as quietly as possible. By daybreak he should have been able to dig a trench some 3 or 4 feet deep, throwing the earth into and in front of his gabions, and thus forming a parapet sufficient to give considerable cover to men in the trench. Just before daybreak, the men who worked at night would be relieved by others who would continue the work by day under cover of the partial protection afforded by the night work.

Sapping.

If the defenders were at all active, the extension of the flying trench work much beyond the second parallel was usually impracticable, and resort had to be had to sapping. Sapping required specially instructed men and was considered as the special province of the sappers or engineers (fig. 36, Pl. XXII). At the very head of the sap a man worked on his knees, digging a narrow shallow trench and throwing the earth into a gabion a little to his front and on the side toward the enemy. From time to time a new gabion would be passed to him which he would push forward into its place by means of hooks, and which in turn he would try to fill.

As the first sapper pushed forward in this manner, a second one, as close behind him as possible, was deepening and widening the trench which the first one had made, throwing the earth on the outside of the gabion already in place. Behind him in turn would be other sappers, widening and deepening the trench.

Of course, the progress of the sap or trench depended entirely upon the progress made by the first man. He was, therefore, relieved frequently and every assistance possible was given him by the men in the rear, in bringing him material and helping him push it forward. Incidentally also, he was sometimes protected in front by what is known as a sap roller. This was a large gabion-like affair composed of two gabions, one about 5 feet in diameter and the other about 2 feet in diameter, so placed that the axes of the two gabions were in the same line and the space between the gabions was filled with brush or earth. Sometimes also, the first sapper had the protection of what is known as a sap shield, a small metal shield placed on the berm between the gabion and the trench. Sometimes this was merely leaned against the gabions, but sometimes it was provided with rollers so it could more easily be pushed forward.

In due time these zigzag saps would have been pushed so far ahead of the second parallel as to require the protection of another parallel known as the third parallel, which would here be built connecting the various approaches. (Figs. 39 and 40, Pls. XXIII and XXIV.) In Vauban's day it was usually possible to build this third parallel at about the foot of the glacis, but sometimes it had to be built farther

CHAPTER IX.

THE ART OF FORTIFICATION IN MODERN TIMES.

This chapter will be devoted to a sketch of the developments in fortification matters during the period beginning where the preceding chapter left off—that is, about the middle of the nineteenth century—and continuing down almost to the immediate present. The reasons for choosing the middle of the nineteenth century as the end of one of the periods into which this sketch of the evolution of the art of fortification is divided were stated near the beginning of the preceding chapter. The end of this period has just been stated rather indefinitely as nearly up to the present. In general, this will be taken as meaning about the beginning of the recent war, the rapid developments during this war being treated in a separate book. Occasionally, however, in discussing a particular matter, the sketch will include some of the developments during the recent war.

GENERAL DEVELOPMENTS.

The developments of general and political history during this period are too well known to require any mention here. In matters connected with the art of war, the principal changes have been the results of the rapidly increasing power and range of firearms. At the beginning of this period infantry fighting was usually conducted in ranks without cover, the two combatants being separated by a comparatively short distance only. During this period, there has been a change from this old style of fighting in ranks to the open order of skirmishers; from the short-distance fighting to infantry battles beginning when the combatants are separated by over a thousand yards; and from exposed fighting to fighting where not only every advantage is taken of the accidents of the ground but where every opportunity is taken to increase by artificial means the protection thus afforded. The effective range of the artillery has increased from a few hundreds to several thousand yards, and artillery fire has become so accurate by the end of this period that in order to preserve the guns themselves from destruction the custom has generally been adopted of concealing the positions of guns and of relying upon indirect fire entirely. The cavalry has been relegated from an arm of great importance in open fighting to one that is useful on special occasions and under special conditions only.

Furthermore, at the beginning of this period air navigation was almost unknown; by the end of the period aircraft had developed into an important arm of the service, not only for obtaining information but for bombarding and for fighting.

Armor.

As was stated at the beginning of the preceding chapter, armor was introduced about the middle of the nineteenth century in the embrasures of fortifications. A few years later, in the operations in the Black Sea, during the Crimean War, the British, with some success, used floating armored batteries against the Russian works.

Scarcely had the Civil War begun in this country when each side made efforts to avail itself of the recent developments in armor. Attempts were made on two fundamentally different plans and resulted, about a year after the war opened, in a battle between the *Monitor* and the *Merrimac*, each a typical representative of the two methods of using armor.

From this time on the use of armor in naval construction became quite common. A number of other monitors were built for the Federal Navy, while rams more or less on the plan of the *Merrimac* were built by the Confederates. These monitors were used not infrequently in the bombardment of the seacoast defenses of the Confederate ports, and though they did considerable damage to the older masonry, they did but little to the earthwork batteries which had been built in large numbers by the Confederates. However, their fire was so effective as to show that the masonry scarp as a type of seacoast fort had outlived its usefulness and, as had been the case some centuries before in land fortifications, exposed masonry could no longer be used in seacoast forts. This matter will be discussed more at length a little later under the heading " Seacoast forts."

Rifle.

At the beginning of this period, the rifle was fast becoming the standard infantry weapon. Its introduction increased considerably the effective range of infantry fire, and during our Civil War it was demonstrated that troops could not stand up against this fire and must seek cover, and that a double line of unbroken infantry firing from parapets over a cleared place in front some 200 yards in width could effectively hold the line against an assault of much larger numbers.

At the time of the Franco-Prussian War, the rifle had been still further improved, fixed ammunition had been invented, and both sides had already adopted the breech-loading principle. The experience of this war was to still further emphasize the deadly character of rifle fire. Incidentally, also, we see in this war the first use of a rapid-fire gun, the so-called mitrailleuse. This weapon, designed for the same purpose as the present machine gun, worked, however, on another principle—that of having several barrels which revolved in front of the breech, each in turn firing a shot as it came to the proper place.

During the operations at Plevna, during the Russian-Turkish War in 1877–78, the Turks showed a great facility in the preparation of entrenchments, and their main defense consisted of very rapid rifle fire aimed at no particular targets but designed generally to cover the entire field which had to be passed over by the advancing Russians. So deadly was this fire that many Russian assaults were repulsed with great loss. The experience of more recent wars has been merely to emphasize the lessons mentionad above as to the efficiency of rifle fire.

Rifled Cannon.

As late as the Civil War, smoothbore pieces were more numerous than rifled, and the large majority of the heavy guns used in seacoast and semipermanent fortifications were also smoothbore. Shortly after the Civil War, however, the use of smoothbore cannon fell rapidly into disuse, and before many years the breech-loading rifle became the standard fieldpiece in all armies.

The same soon became true of the heavier guns designed for use in sieges and for seacoast use. Smoothbore guns were entirely done away with and breech-loading rifles were introduced. The mortar was the last of the smoothbore pieces to be retained, but it also was finally superseded by the breech-loading howitzers.

The introduction of rifled cannon and the accuracy of fire and the greatly increased range due thereto, had a great effect upon the design of permanent fortifications and upon the conduct of siegework as will later be referred to more at length.

Railroad Cannon.

During this period also, railroad cars began to be used as mounts for cannon. The first attempt at this was during the siege of Petersburg, when Col. Henry L. Abbot, an officer of engineers, temporarily in command of a heavy artillery regiment, placed mortars on strengthened railroad cars and used them with effect against the Confederate works. This experiment, however, seems not to have been repeated for many years, during which the development in cannon went on much more rapidly than the development of railroad materials. However, during the South African War, the British armored some of their railroad locomotives and mounted small cannon in armored railroad cars.

After this time several European nations began to experiment with railroad mounts for large guns, each nation, however, keeping confidentially the results of its experiments. Apparently the Germans were the most successful in this particular, and shortly after the recent war broke out, they sprung upon the military world a number of surprises, in their ability to transport heavy guns on railroads and to fire them from cars with but comparatively minor preparation of the site.

COMMUNICATIONS.

As with the other branches of the art of war, the development of the art of fortification during this period has been very rapid, and this development has probably been greatest in connection with the subject of communications.

Railroads.

At the beginning of this period, railroad development was in its infancy, railroads having been constructed in the thickly settled communities and connecting the larger cities only. They soon spread rapidly, until they are now in existence in all civilized and even in some of the partially civilized sections of the world. Although railroads were used to some extent by the French and Austrians in the movement of troops during the war in northern Italy, the American Civil War was the first in which railroads became the principal method of communication.

From the very beginning of this war, both in the North and in the South, railroads were used for moving troops from the points of mobilization to the points of concentration at least, and for carrying them still farther forward when practicable.

Tactically, also, railroads played a fairly important part. Thus the Battle of Bull Run, the first pitched battle of the war, was turned from a Confederate defeat into a Confederate victory by the arrival of a small body of troops sent in by rail. Later, in the fighting around Chattanooga in the late summer of 1863, the railroads likewise played an important part. So important was this fighting considered that both sides undertook to rush in troops from Virginia. Longstreet's corps of the Confederate Army, having the shorter distance to go, arrived in time for a large portion of this corps to take part in the Battle of Chickamauga. Hooker's army, composed of two corps of federal troops, having a much more roundabout way to go, did not arrive until after this battle. Sherman's move forward from Chattanooga to Atlanta in 1864 was rendered possible only by the use which he made of his railroads and the skill of his railroad engineers in accomplishing almost impossible tasks of hastily constructing bridges over almost impassable ravines. Both of these incidents are good examples of the offensive use of that branch of fortifications that deals with communications.

During the Franco-Prussian War both the German and French railroad systems played an important part in the mobilization and concentration of troops on their respective sides. In this operation, however, the Germans were far more successful. They were consequently able to make a rapid advance in France before the French Army was fully mobilized and concentrated. This forward movement to France was made so rapidly and in such large numbers that the railroads themselves were but little used in moving troops, although they later became of great importance in keeping the German Army supplied.

During the Russo-Japanese War in Manchuria nearly all of the fighting was along the main line of the Manchurian railroad, and the final failure of the Russians was supposed to be largely due to the inability of the trans-siberian railroad to fulfill the demands placed upon it by the operations in the field.

The success of the British in the South African War was largely due to their skill in maintaining and defending railroads which were thus able to properly fulfill their logistic functions.

In the United States and in most of the english-speaking countries railroads have been constructed for commercial reasons only, but upon the European continent military reasons have been given great weight. Thus, in Germany, all the probable desirable points of concentration near the boundaries have been connected with the mobilizing points in the interior by railroads designed primarily for the purpose of rapidly concentrating troops upon a frontier. The planning and construction of these railroads properly pertain to the art of fortification. That these railroad systems had been skillfully designed was shown clearly by the rapidity with which German troops were mobilized and concentrated on the eastern and western boundaries during the recent war.

Similar systems had been designed by the French and, to some extent, by the Russians. The Russian government, however, on account of the great extent of its country and the necessary slowness of mobilization, had realized that its neighbor on the west would probably be the first to be mobilized and that, therefore, what was necessary or most desirable in war was not so much the ability to concentrate their own troops near their extreme western boundary as to make their own railroads near that boundary as of little assistance as possible to an enemy invading from the west. They, therefore, used a different gauge in their railroads from those which the Austrians and Germans used, thus making it essential in case of an invasion from the west that the enemy should either put new trucks on all their cars or else should relay one rail of each track.

During the recent war the strategic railroad systems in Europe proved most efficient, enabling armies of hitherto unequaled size to be mobilized and moved with almost unexpected rapidity. Later, the railroads permitted the great problems of supplying these large armies to be satisfactorily solved. In fact, so easy had become the problem of moving forward the supplies of an army that it was seen that, due to this ease of supply, a much larger expenditure of ammunition was permissible than either side had thought possible before the war, with the result that the expenditure of ammunition became dependent not upon the rate at which it could be carried up to the guns, but upon the rate at which it could be manufactured at home.

For the movement of troops and supplies from the rear up to near the field of operation, reliance was had upon standard gauge railways; but for the movement of supplies in the immediate field of operation, recourse was had to a great extent to narrow-gauge railroads, which could be built much more rapidly than standard-gauge roads, and which were not so limited by conditions of grade and curvature. The locomotives for use upon these narrow-gauge roads were almost exclusively gasoline actuated, since gasoline gives no smoke and, therefore, does not betray the position of the locomotives.

Roads.

Western Europe having been highly civilized for many centuries before the introduction of railroads, it had been necessary to construct systems of highly improved highways for the transportation of individuals and for commerce. In this section of the world, therefore, the railroads were considered first merely as supplemental to the old highways, and the highway systems were still well maintained and extended.

In America, however, the beginning of the era of railroads found a country but thinly settled, the towns being widely separated. Railroads were used, therefore, not only to connect centers of population already in existence, but to a great extent for developing the country. The railroads gave the towns through which they passed much better communication with the outside world than was possible for the towns not on the railroad and, consequently, it was, as a rule, only the towns located on the railroad which later developed into cities.

For intercommunication between these cities, both for passengers and for freight, the railroads became the main dependence and the highways became merely a means of communication between the country and the nearest railroad point. Unfortunately, this condition resulted in a general neglect of our highways, which has continued with little change up to the present time.

During our Civil War the armies had to depend for local communication on existing roads, and except in good weather transport by road was greatly hindered by the almost impassable conditions of such roads. At various times it became necessary to construct roads for the use of the armies, but the enormous extent of roads necessary was so great that comparatively little was accomplished in this way.

Fortunately, in the last few years, under the impetus first of the bicycle and then of the automobile, and later of the automobile truck, there has been a tendency among the more progressive communities to a great improvement in the conditions of the roads, and it is hoped that before long this will have spread throughout the country so that all cities and manufacturing centers will be interconnected by good highways.

The usefulness of highways for military purposes has been greatly enhanced in recent years by the development of the auto truck. Auto trucks require good roads and strong bridges, and the military necessity for these was accentuated. The provision of such roads is a part of fortification and a function of the engineer.

During the recent war many attempts were made to persuade Congress to embark upon the construction in this country of a system of strategic highways, but so far these efforts have been almost unavailing.

Military Bridges.

In Chapter VI mention was made of two examples of military bridges—Xerxes' bridge of boats over the Hellespont, and Caesar's trestle bridge over the Rhine. Many other examples can be found in history, for it is evident that wherever a large and unfordable river has to be crossed by an army some kind of a bridge is necessary.

In ancient times, as a rule, such bridges had to be improvised from material found in the neighborhood. If boats were needed, they were either seized where they could be found, or were constructed. We do learn, however, that, in certain cases, the Persian, Greek, and Roman Armies carried with them skins which could be inflated with air or filled with pieces of wood, and which, when inflated, could be used as the floating supports for light bridges.

During the Middle Ages, the conditions of highways and other communications prohibited the carrying of bridge material with an army and, in fact, it was not until the latter part of the seventeenth century that any such transport of bridge material was attempted. It is stated that the French and German Armies at that time carried with them material for making rude pontons by covering framework of timber with some kind of a covering, leather, tin, or sheet copper.

By the time of Napoleon, the highway systems of Europe had been much improved and it was possible to carry bridge material with the army when urgently needed, and the matter was, therefore, somewhat systematized.

It was during the Civil War that the American Army found its first use for bridge material. A large part of the field of operations, especially eastern Virginia, had running through it a number of wide and deep rivers, and the line of march of the army passed across a number of these rivers. Bridge material thus became necessary.

The bridge equipage then adopted was based upon the system used by the French Army, consisting of wooden ponton boats and the necessary beams and floor timbers, all of which could be carried on wagons. This equipage, however, was somewhat heavy and, as the roads through the section of the country were exceedingly poor, especially in rainy weather—the very time when the rivers are high and bridges are most necessary—a lighter form of bridge equipage was found to be necessary. To fill this need, there was invented the light canvas ponton. This ponton consisted of a framework, which could be put together rapidly, and then covered with a properly designed piece of canvas. When not in use, the parts of this bridge could be easily packed and carried in the ordinary army wagon. A form of portable trestle was also developed which could be used independently or in connection with either form of ponton.

The general form of bridge equipage then developed has been in service up to the present time, only minor modifications having been found to be necessary.

On the Continent, however, on account of the scarcity of timber suitable for ponton construction, metal ponton boats have been substituted for wooden to a great extent. As a rule, the metal boat is heavier than a wooden one; and to avoid too large a unit weight, it has been customary to divide the pontons into two sections which can be fastened together in the field when needed.

FIELD FORTIFICATION.

As has been previously stated, in the wars which took place prior to this period, fortifications were but little used by mobile armies in the field, at least where the combatant forces were European troops. Occasionally, where a battle line included a village, houses, hedges, or stone walls, the troops would make some use of the protection thus given; but, in general, no such work as digging trenches or rifle pits was attempted in field operations.

In the early battles of the Civil War, no attempt was made to prepare defensive works, but the rifle then in use was soon shown to be so very effective that it was not many months before it became customary for the troops on both sides to throw up and make use of hastily constructed protective works. If the troops were stopped even momentarily in the presence of an enemy, advantage would be taken of existing trees, rocks, logs, or accidents of the ground, or in the absence of these, a small mound of earth would be thrown up to give protection. If an advance was made at once, of course, such little protections would be abandoned, but if the position was to be held for any length of time, the digging would be continued until eventually a line of rifle pits or a trench would result. Wherever either army found itself temporarily in the line of advance of the enemy, lines of intrenchments or rifle pits were thrown up and later, if the threat of the enemy became greater, these lines were strengthened by the construction of ditches, abatis, and other obstacles.

So common was this resort to hastily constructed defenses that before the Civil War was over, intrenching tools became a regular part of the equipment of infantry troops. The Confederate defenses, constructed near Fredericksburg, Va., were of the character described, and they were so strong as to repulse with heavy losses a number of assaults by the Federal Army. Eventually, these defenses had to be turned.

Similarly, when Gen. Grant, in the spring of 1864, started his advance from the Potomac to the James, he found himself opposed by hastily constructed Confederate works. An assault upon these having proved futile, he moved his army by the flank, turning these works, only to find himself confronted by still others and so on, until he had reached the James River.

At about the same time, Gen. Sherman, advancing from Chattanooga to Atlanta, found himself confronted at almost every stage of the campaign by Confederate defenses, which were too strong to be taken by direct assault and had to be turned. Before going far in the new direction, he found himself again confronted by similar works, and these also had to be turned.

In Grant's advance upon Richmond and Sherman's advance upon Atlanta, these defenses were eventually turned, but, nevertheless, they must be considered to have fulfilled their purpose in that they caused the Federal Army to suffer much heavier losses than were suffered by the Confederates fighting behind breastworks. Furthermore, they were also the cause of many weeks' delay, permitting the defenses of Richmond and Atlanta, respectively, to be much strengthened, and giving time also for the organization and equipment of additional Confederate Armies.

SEMIPERMANENT DEFENSES.

At the beginning of the Civil War, there were no permanent land fortifications in the United States, the only permanent works then existing being the seacoast forts, constructed at the various harbors. These seacoast fortifications, however, were usually provided on the land side with defensive works designed to repel land attacks.

Early in the war, however, the necessity of defensive works around some of the cities became evident. Especially was this true of the two capitals, Richmond and Washington. The defensive works at these two places were of essentially the same character. Gen. Barnard, an engineer, has written a book called "The Defenses of Washington," describing in detail these defenses, and the following brief account of these defenses is taken from this book.

Defenses of Washington.

The Civil War opened to a rather unique condition, the capitals of the two opposing forces being large cities, situated but slightly over 100 miles apart and both absolutely undefended. The first troops raised on either side were rushed to the defense of their respective capitals, and work was, of course, immediately commenced upon the fortification of these cities.

Washington, the capital of the Federal forces, is situated on the left bank of the Potomac River, the right bank opposite being a portion of the State of Virginia and, therefore, nominally a part of the Confederacy. Furthermore, the State of Maryland, which surrounds the city of Washington on the left bank of the Potomac, was, as far as the sympathy of the majority of its people was concerned, strongly inclined to join the Confederacy, and was only restrained by occupation by Federal troops (Pl. XXV).

The war may be said to have been opened in April, 1861, by the bombardment of Fort Sumter. Almost immediately Federal troops were hurried to Washington and were advanced across the bridges leading into Virginia, and constructed small bridgeheads on the farther side. This condition continued for about a month, when a further advance was made into Virginia so as to include within the lines the city of Alexandria and the hills around Arlington. Here additional defenses were erected.

Believing that the war would be but a short affair and would end quickly, no further attempt to fortify Washington was made until July, after the Battle of Bull Run. As a result of this battle, the Federal Army returned somewhat hastily to the defenses of Washington, the Confederates being, however, too greatly demoralized to make a vigorous pursuit, or to attempt an attack upon the meager defenses of Washington.

This event, having invited attention to the comparatively undefended condition of the Capital, a series of strong works was at once built around the city, covering especially all the main roads and lines of approach. The construction of these defenses and the advance of Gen. McClellan's army toward Richmond apparently impressed Congress with the idea that no other defenses were needed, and consequently an appropriation bill passed in the early part of 1862 contained an item to the effect that no funds should be spent upon any works in the defenses of Washington which had not already been begun.

However, the peril in which the Capital was placed in the late summer of that year, due to the advance of the Confederate Army, was such as to show the necessity of additional defenses. Accordingly, a commission, with the Chief of Engineers as its head, was organized to inspect the existing defenses and to suggest additional works. This commission investigated the subject and suggested a number of new works, which were built during the winter of 1862 and 1863.

The defended area included the cities of Washington and Alexandria. Beginning on the right bank of the Potomac just below Alexandria, the defensive line extended around the city of Alexandria and followed a range of hills about 3 miles from the Potomac, until above the city of Washington. Here the line bent toward the river again, touching it about a mile west of the Aqueduct Bridge. Farther up the Potomac River, on the same bank, a series of redoubts were constructed, forming a strong bridgehead around the west end of the Chain Bridge. On the left bank of the Potomac, the line began above the Chain Bridge and extended around north and east of the city, and eventually reached the Potomac River nearly opposite Alexandria (see Pl. XXV).

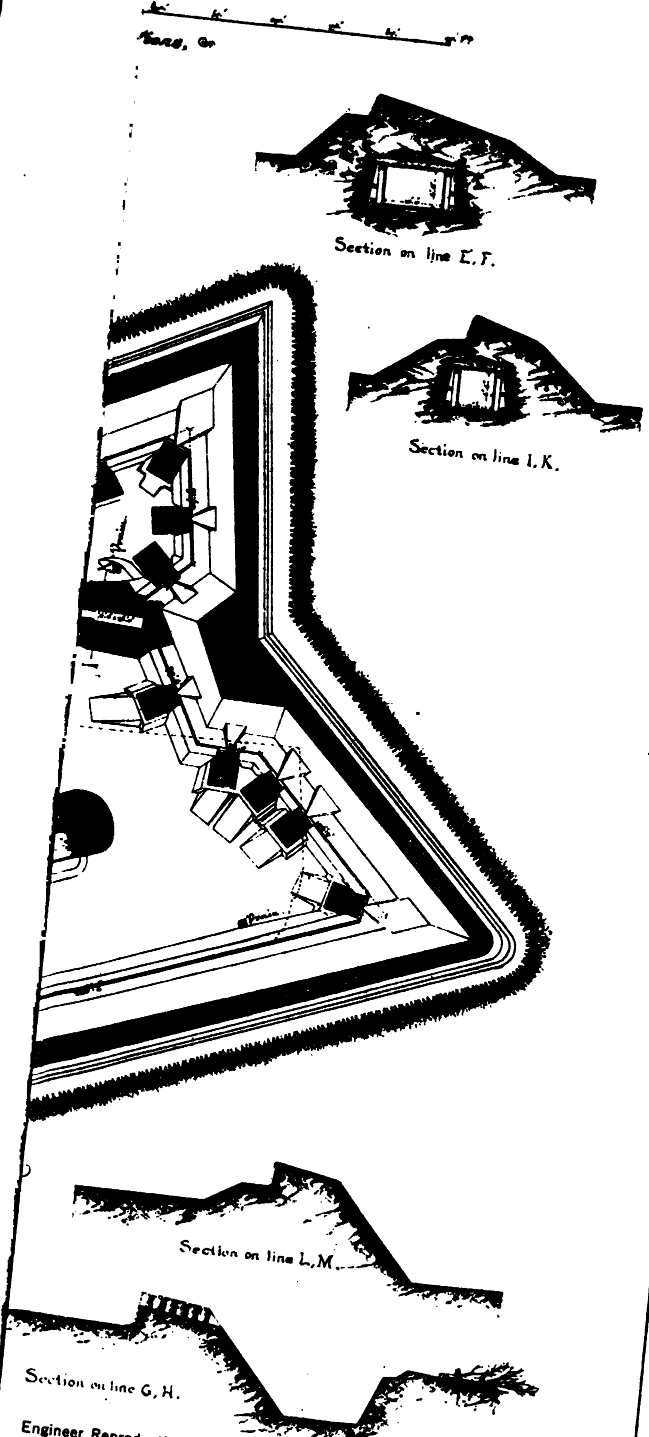
In general, the defensive line consisted of a series of detached forts and redoubts well located and specially designed to suit the locations. The enceinte of these redoubts consisted in general of an earthen rampart. In the smaller forts the trace was usually simple, the larger forts, however, having bastion fronts. The fronts of these fortifications, facing toward the enemy, were fitted generally as artillery positions.

The spaces between the guns were prepared for infantry, and in the gorges toward the rear, infantry parapets only were prepared. As a general rule, the guns were so mounted as to fire through embrasures, though occasional guns were mounted in barbette so as to have a wider angle of traverse. Traverses were introduced at intervals when necessary so as to protect the guns from the effects of enfilade fire. On plates XXVI, XXVII, XXVIII, XXIX and

Fig. 43

Fig. 43

PLATE XXVII



Section on line E, F.

Section on line I, K.

Section on line L, M.

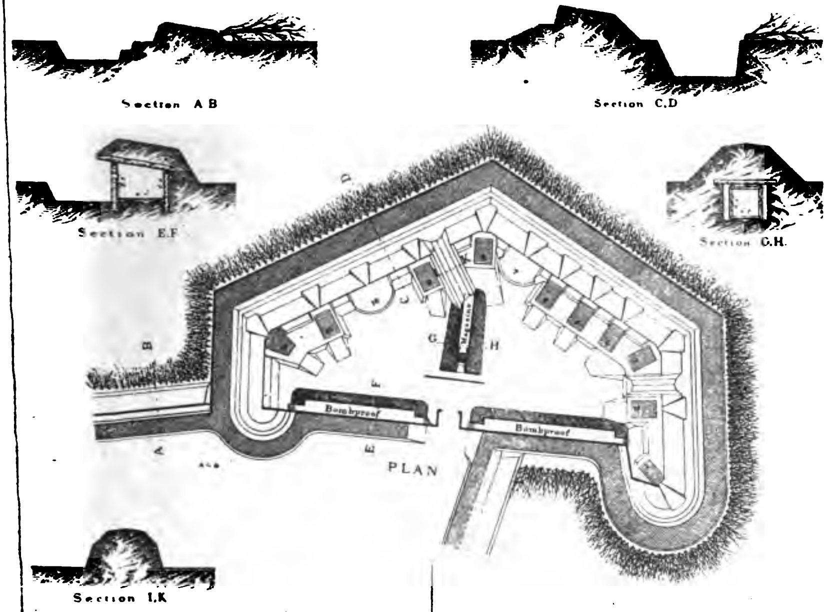
Section on line G, H.

led from Re

Engineer Reproduction Plant, U. S. Army, Washington Barracks, D.C.
1919

1335-2

FORT WEED



ARMAMENT

Nº 1	Platform for	Field Gun		
" 2	Do "	Siege "	30 Pdr.	Parrott
" 3	Do "	Do "	30 Pdr.	"
" 4	Do "	Do "	30 Pdr.	"
" 5	Do "	Do "	30 Pdr	"
" 6	Do "	Do "	80 Pdr	"

Scale of Plan

100' 50' 0 100

ARMAMENT

Nº 7	24 Pdr. on Barbette Carriage			
" 8	Platform for	Siege Gun		
" 9	Do "	Do "	30 Pdr	Parrott
" 10	24 Pdr on Barbette Carriage			
" 11	Platform for	Field Gun	12 Pdr	Brass Hu
" 12	Do "	Do "	12 Pdr	Do

Scale of Sections

10 0 10' 20' 30' 40 50

Copied from Report on Defences of Washington, by Bvt. Major General J. G. Barnard.

FIG. 42.

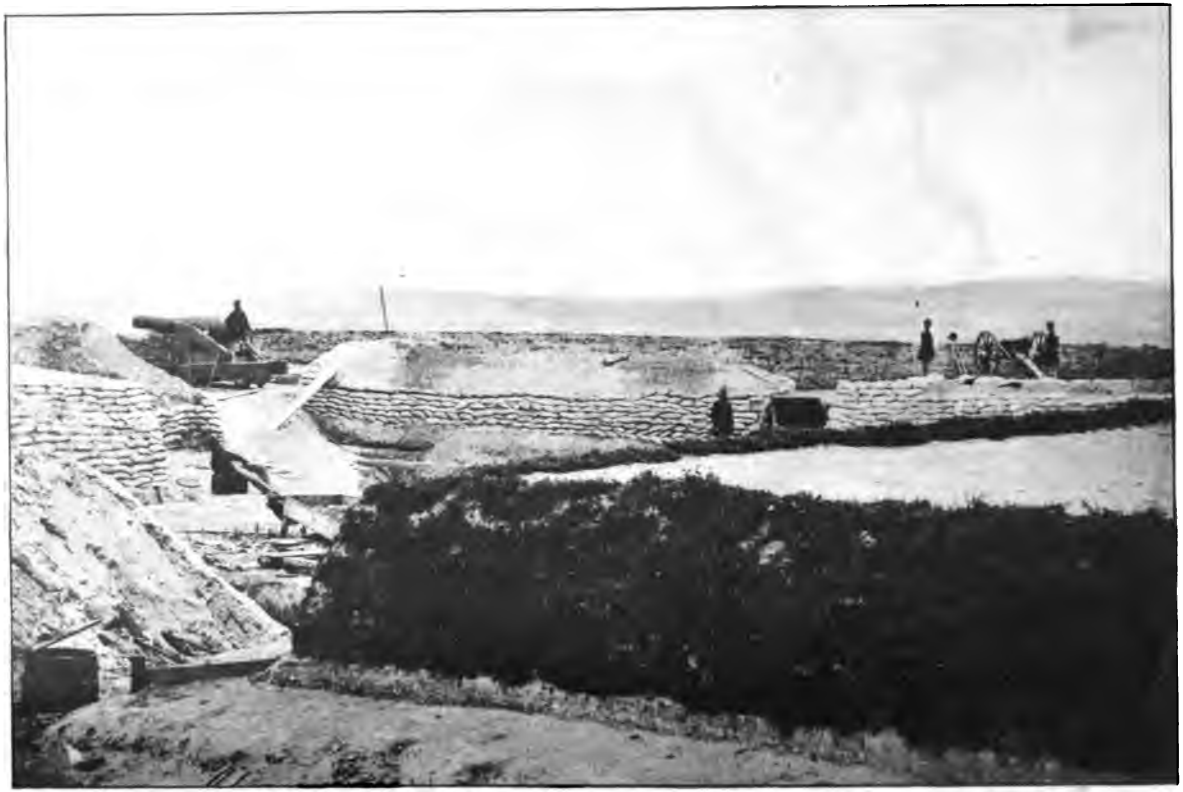


FIG. 44.—INTERIOR VIEW OF FORT DEFENSES OF WASHINGTON.

PLATE XXIX.

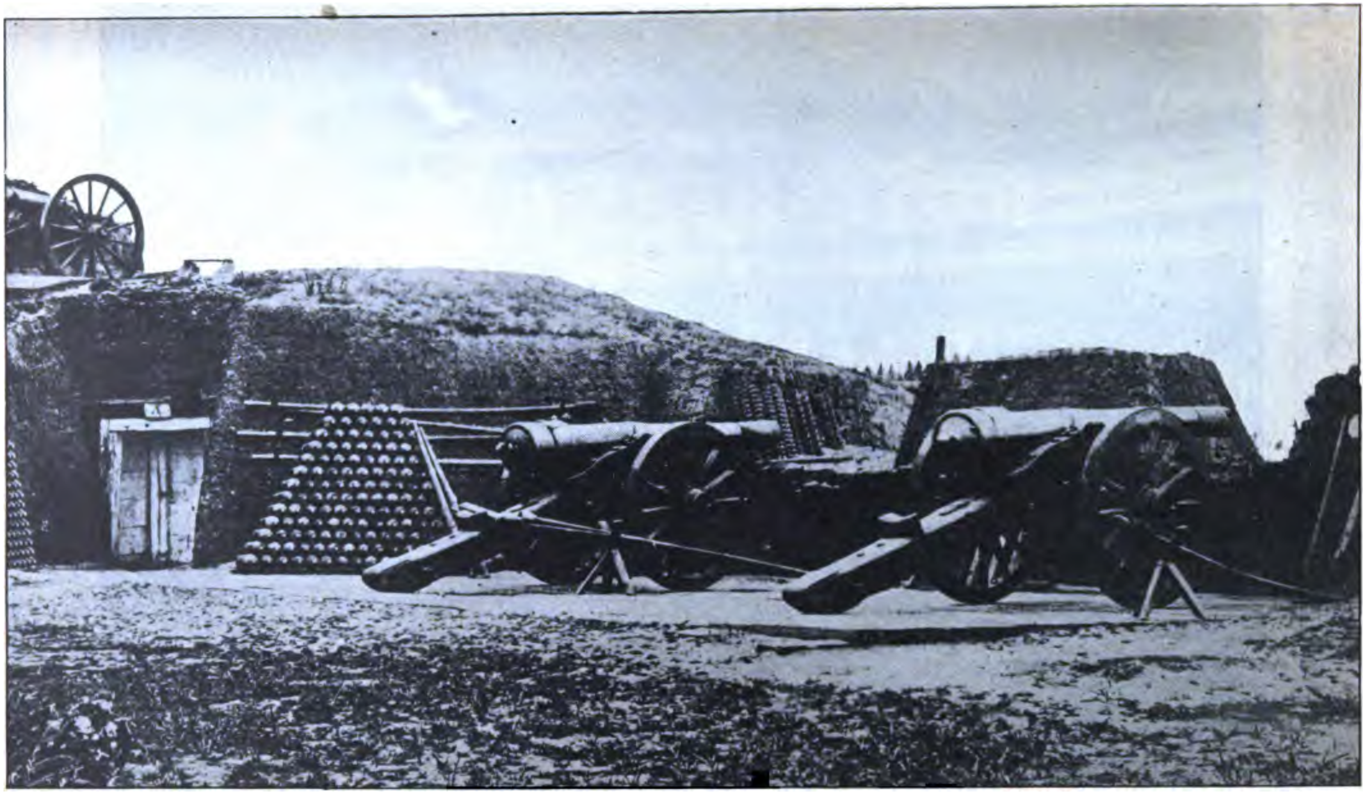


FIG. 45.—FORT PUTNAM—DEFENSES OF WASHINGTON.

PLATE XXX.

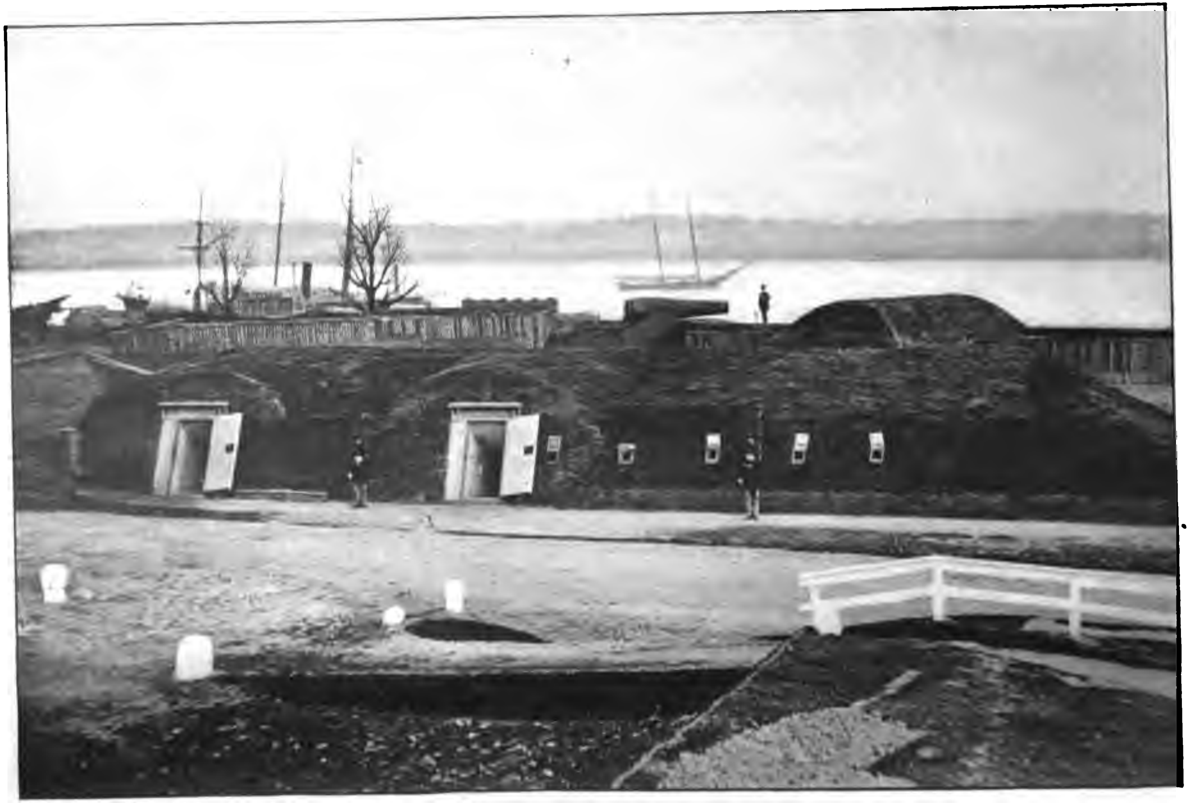


FIG. 46.—FORT ON THE POTOMAC RIVER—DEFENSES OF WASHINGTON.

XXX are shown plans, sections, and photographs of some of the forts which may be considered as typical of the others.

The profile of these forts consisted of an earthen parapet from 12 to 18 feet thick (the thickness depending upon exposure). The interior slope was revetted while the exterior slope was allowed to take the natural slope of the earth. At the foot of the exterior slope proper, there was a narrow berm, outside of which there was a ditch at least 6 feet in depth. Outside of the ditch the ground was graded so as to form a glacis with a narrow covered way fitted occasionally as an infantry parapet. On the glacis or at its foot there was usually built an abatis. When first constructed, the interior slope was revetted with planks, but these proved to have so little durability, they were later replaced by a revetment consisting of vertical posts, capped by horizontal logs which were well tied back into the parapet.

Within the forts, bombproof magazine and bombproof quarters were plentifully supplied and the earth covers of these were frequently fitted as infantry parapets.

Incidentally, and for moving troops to and from these defenses and between them, well-paved military roads were built, passing in rear of and interconnecting all the forts and crossing all the various pre-existing county roads radiating from Washington and Alexandria. We have here a good example of the defensive use of communications.

In general, and in order to save the troops as much as possible, most of the labor was performed, not by troops, but by hired negroes working under charge of engineer officers.

When completed the defenses of Washington consisted of 68 forts or redoubts containing emplacements for over 1100 guns, about 800 guns, and approximately 100 mortars being actually mounted. Of the guns, slightly more than half were smoothbore, the largest except in the forts on the river banks, being the 8-inch howitzers. Of the rifled guns, the 24 and 30 pound parrotts were more numerous than any others. Of the mortars, a few were of 10-inch caliber and the others were mostly 24-pound coehorns.

In addition to the forts proper, there were between the forts, and forming as it were the curtains, some 20 miles of rifle trenches and a few emplacements for field guns. The redoubts were so numerous and were so well placed that all the area within range was well swept by artillery fire and no good sites were left for the enemy's field guns that were not swept by a crossfire of guns from the forts.

The Potomac below Washington, which is a navigable river, was defended from naval attack by a semipermanent work, Fort Foote, on the Maryland shore, and by a battery nearly opposite, on the Virginia shore, these forts being armed with 200-pound parrotts and 15-inch smoothbore guns.

As was stated in the beginning of this section, progress on the construction of the defenses of Washington proceeded somewhat irregularly. When things were progressing well for the Federal side, work was almost stopped, whereas, during times of peril, or rather it might be properly said immediately following times of peril, work was pressed vigorously. Not only was the construction irregularly pushed, but later there was a tendency when the need of the field armies seemed great, to ship guns from the defenses of Washington to the armies whose need for the time being seemed greater, and there was a still more dangerous tendency to constantly send forward from Washington to the armies in the field well-trained troops and to replace them by raw troops just raised.

These defenses served their purpose well. Thus, in the fall of 1862 the Federal Army which had been worsted in the field fell back to the defenses of Washington; whence, after a few days of rest and after the arrival of reenforcements, it was ready to move forward to the successful campaign which ended in Antietam. In 1863, when Gen. Lee made his invasion of the northern states, which ended in Gettysburg, the defenses of Washington were so strong that he did not even attempt to confront them, aiming rather at the capture of Philadelphia and Baltimore. The following year, 1864, when Gen. Early made his rapid advance through the Shenandoah Valley and marched to Washington, he made a demonstration upon the defenses. These defenses, as was well known to him, had been recently stripped of nearly all of their disciplined and instructed troops, and these trained troops had been replaced by raw recruits not yet trained. However, a few veterans from the Army of the Potomac arrived in town, and so strong were the defenses that after little more than a demonstration Gen. Early withdrew. On this occasion at least these defenses saved the city.

Defenses essentially similar in character and purpose to those above described as having been constructed around Washington were built by the Confederates around Atlanta and in front of Richmond and Petersburg, and in a few other places (Pls. XXXI, XXXII, XXXIII, and XXXIV). Those in front of Richmond and Petersburg were so well built and were so stoutly defended that they were never taken, though subjected to what was almost equivalent to siege for nearly a year. Finally, they were turned and abandoned, but only during the very last days of the war.

USE OF FIELD WORKS AFTER THE CIVIL WAR.

The deadly character of rifle fire and the necessity of hastily provided cover as a protection against this fire, which had been developed during our Civil War, seems in Europe not to have been realized

PLATE XXXI.

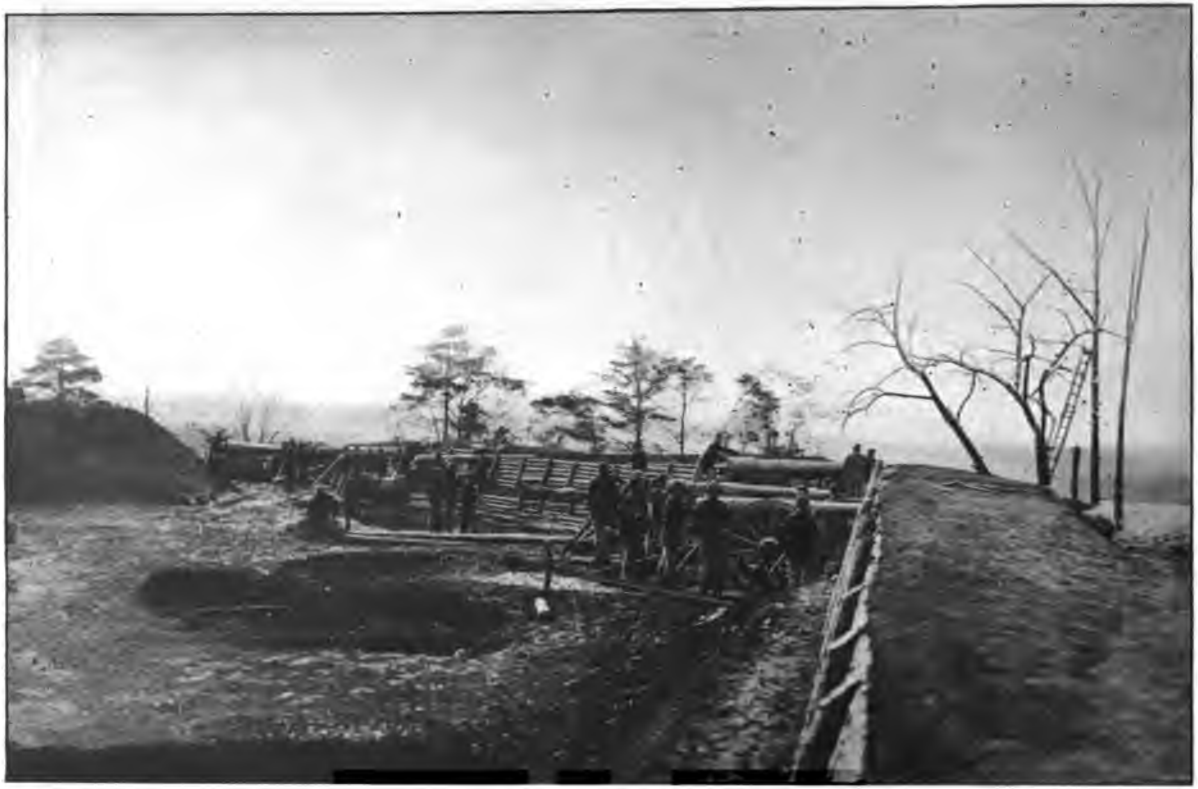
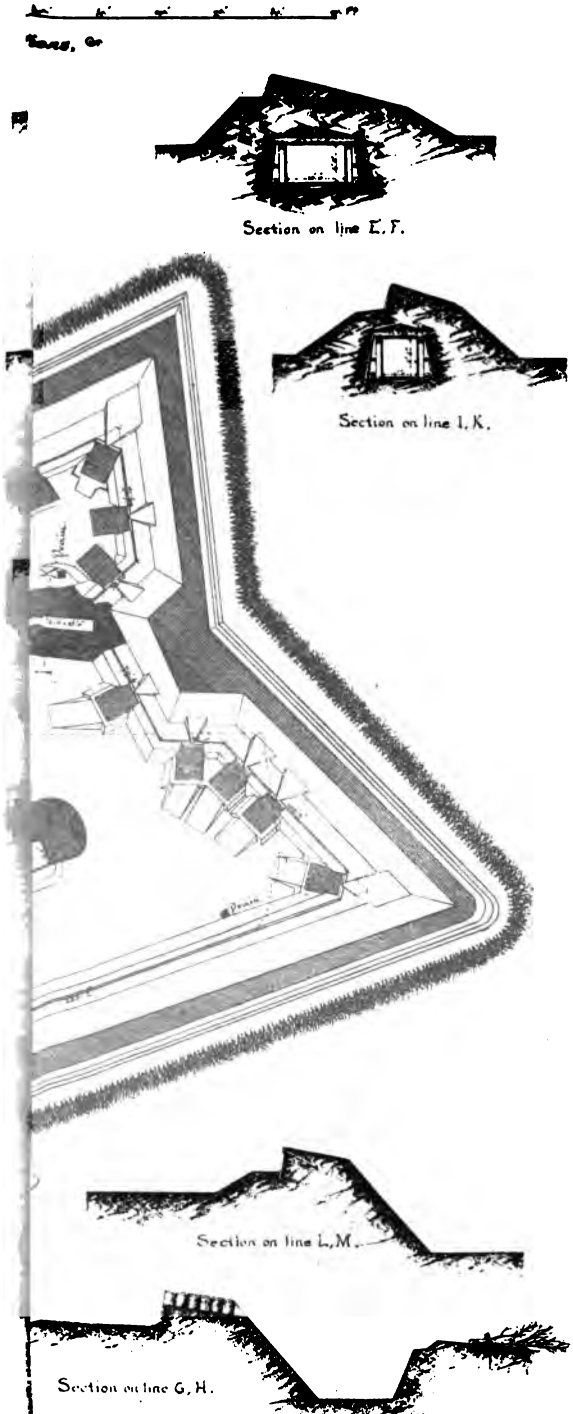


FIG. 47.—BATTERY IN FRONT OF PETERSBURG, VA.

Fig. 43

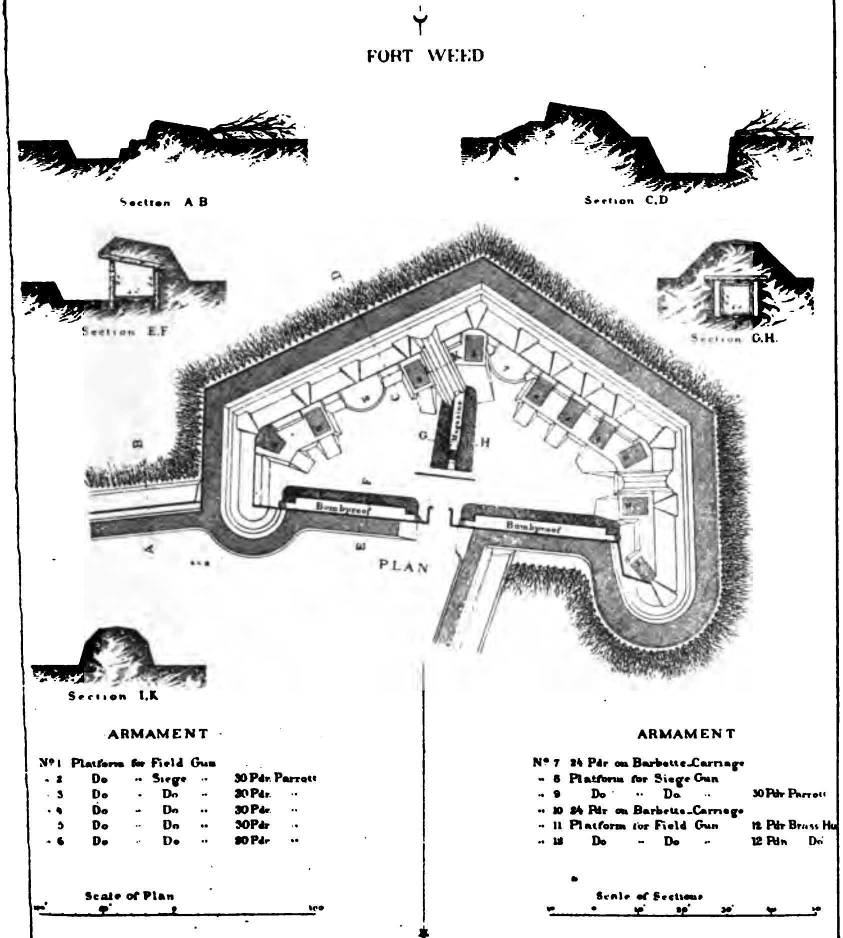
PLATE XXVII



Engineer Reproduction Plant, U. S. Army, Washington Barracks, D.C.
1919

1335-2

Copied from Rep



ARMAMENT

Nº 1	Platform for Field Gun	
„ 2	Do „ Siege „	30 Pdr. Parrott
„ 3	Do „ Do „	20 Pdr. „
„ 4	Do „ Do „	30 Pdr. „
„ 5	Do „ Do „	30 Pdr „
„ 6	Do „ Do „	20 Pdr „

ARMAMENT

Nº 7	24 Pdr on Barbette Carriage	
„ 8	Platform for Siege Gun	
„ 9	Do „ Do „	30 Pdr Parrott
„ 10	24 Pdr on Barbette Carriage	
„ 11	Platform for Field Gun	12 Pdr Brass Hu
„ 12	Do „ Do „	12 Pdr Do

Copied from Report on Defences of Washington, by Bvt. Major General J. G. Barnard.

FIG. 42.

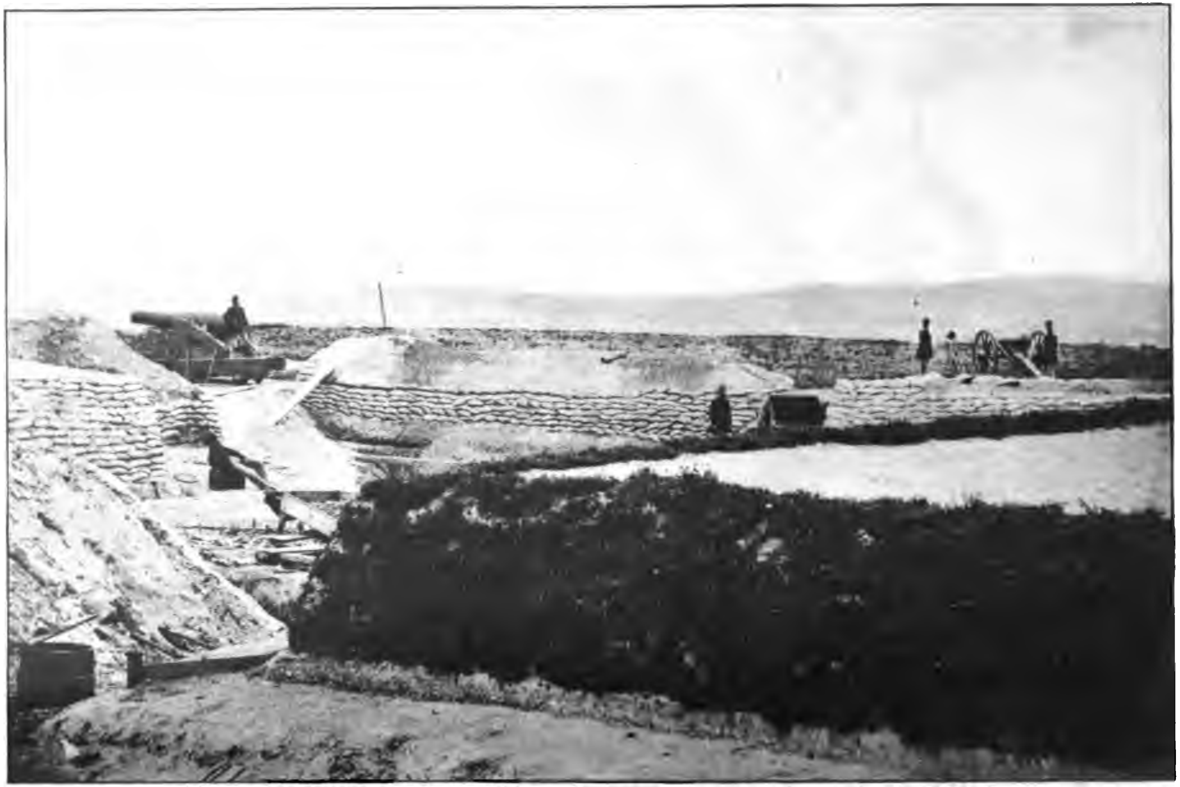


FIG. 44.—INTERIOR VIEW OF FORT DEFENSES OF WASHINGTON.

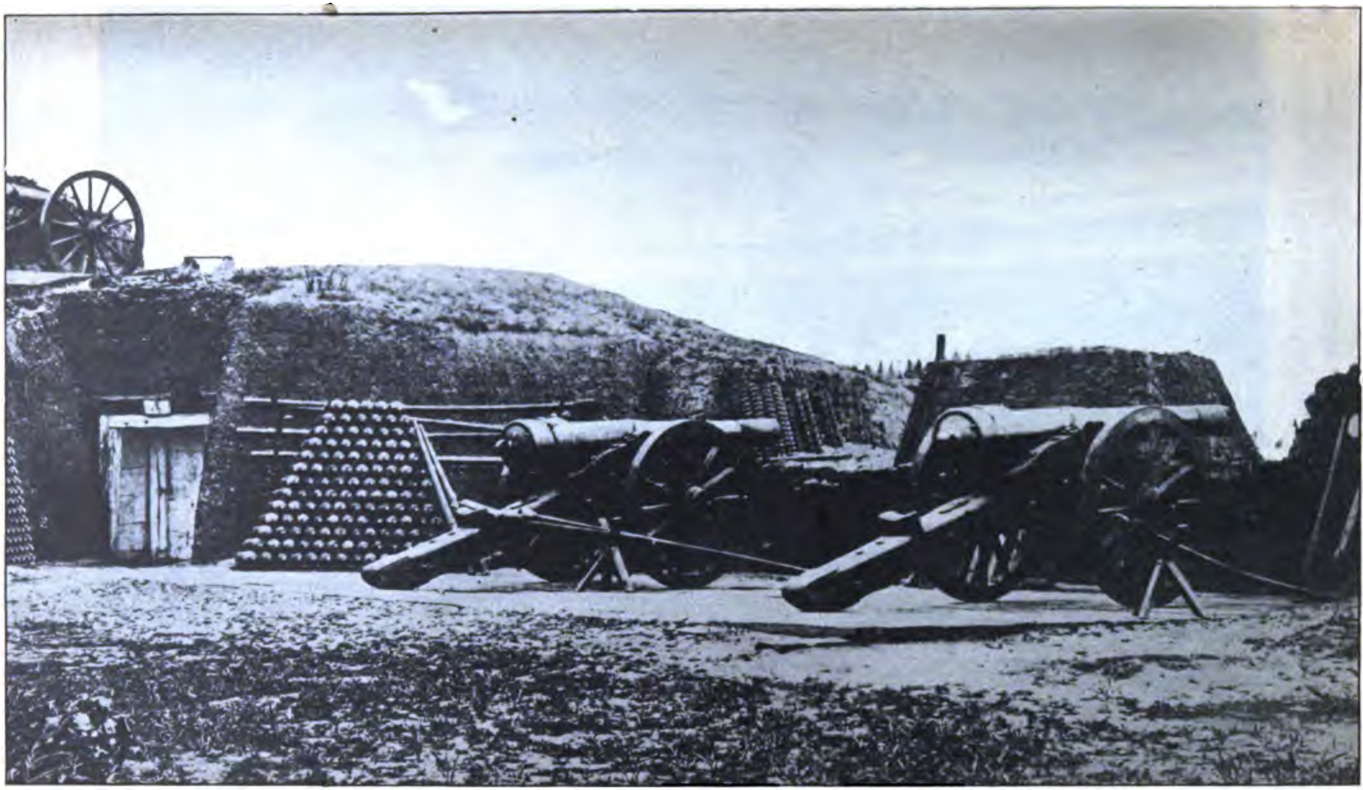


FIG. 45.—FORT PUTNAM—DEFENSES OF WASHINGTON.

the French people early successes followed by an invasion of Germany. Instead of these successes there had been a number of reverses, seriously trying the temper of the French people. Bazaine was in command of the most advanced of the French Armies, while McMahon was attempting to organize another large army in the rear. A retreat of the French from Metz, whatever the cause, would in all probability have tried the temper of the French people to the breaking point, with the very probable result of the early overthrow of the French Empire. Although intended probably to save the empire, the action of Marshal Bazaine in taking refuge in Metz probably hastened the end, for only a few weeks later the other French Army, and the emperor himself who was present with it, were compelled to surrender at Sedan. Had Bazaine, instead of placing his armies in Metz, fallen back and joined McMahon's army, leaving in Metz only the regular garrison for which it was prepared, the fortress would probably have held out much longer, and the combined French field armies would doubtless have been able to have prolonged the field struggle. This is probably all they could have done, for it would appear when the relative strength of the two sides is considered that the French were doomed to defeat from the beginning.

However, it should be noted that the delay caused to the Germans in besieging and capturing the city of Metz gave the French valuable time which was spent in strengthening the defenses of Paris. These defenses, in spite of their being subjected to the attack of guns of a strength not contemplated when the defenses were planned, were enabled to hold out until another French Army could be raised in southwest France. Had this French Army been able to defeat the Germans in the field, Paris would have been saved, but they were hastily raised, poorly equipped, and their attempt to relieve Paris failed.

Of the sieges subsequent to the Franco-Prussian War the development of rapid rifle fire by the Turks at Plevna have been noted. Subsequently to the latter, there were no developments worthy of note until we come to the siege of Port Arthur, in the Russo-Japanese War. The defenses of Port Arthur were comparatively modern, consisting of a series of detached works with an older enceinte behind. Exterior to the outworks, there were a number of prominent hills which should have been fortified. Some of these the Russians attempted to fortify in a half-hearted kind of way. Others they neglected entirely.

When the Japanese advanced to an attack, the extreme outlying works were captured easily. The Japanese made a general assault on the main works, were repulsed, and then commenced regular siege operations. These operations were conducted on the same general principles laid down by Vauban, altered, of course, as required by the development in fire arms. The light, easily constructed parapets used by Vauban gave insufficient protection and, consequently, the shallow sap could no longer be used. All advances were made by the deep sap, which work was correspondingly slow. The bombardment was commenced at a much greater distance and was carried on largely by indirect fire. The zig-zag trenches were started at a much greater distance from the works than Vauban could ever have thought necessary. Searchlights were utilized to interfere with night work. On some portions of the lines, the Japanese attempted assaults from time to time. In others they used sapping right up to the crest of the glacis itself, then tunneled down and broke into the counterscarp galleries, in which galleries fighting in the dark continued for several days.

For a while, the Russians made a fairly active defense, repairing by night as well as they could the damage that had been done by day, and building interior works to still further delay the Japanese when they had captured some of the more advanced works. Unfortunately, after the siege had progressed for approximately six months, the chief engineer of the Russian Army and some of his staff were killed by a lucky Japanese shot. Thereafter, the Russian defensive morale was considerably reduced and the fort surrendered before many weeks.

However, in spite of its ultimate fall, Port Arthur had accomplished all that could be reasonably expected. It had for many months held back from participating in the main fighting, a Japanese Army outnumbering the garrison by several times. Had the main Russian Army been able to take advantage of this delay, or rather had the Siberian and Manchurian Railways been able to bring up the Russian troops with sufficient rapidity, the Russian Field Army, before the end of the Port Arthur siege, would have been increased to a size sufficient to enable it to defeat the Japanese in the field in central Manchuria.

PERMANENT FORTIFICATION.

As was stated near the beginning of the preceding chapter, the middle of the nineteenth century was marked by a tendency in permanent land fortification, to abandon the closed enciente and to resort to lines of detached forts. This system was started by the Germans about 1830 and was followed in a few years by the French and Belgians.

At first, these detached forts were but fortresses in miniature with bastion fronts, masonry scarps, etc., such as had previously been popular, but the general introduction of rifled cannon, their very long range and their ability to concentrate curved fire within a comparatively limited area, soon caused a change. The high scarp walls and the semidetached scarps were quickly abandoned, and a low detached scarp was substituted instead, except on the rear fronts or across the gorge (fig. 16, Pl. VIII).

There was also a rapid evolution in the positions of the detached forts. At first they were placed only a thousand yards or so in front of the ramparts, but this distance showed a tendency to a rapid increase and before long had been extended to 3,000 or 4,000 yards. Later still, toward the end of the century, these detached forts were located from 8,000 to 12,000 yards in advance of the main line of works.

Of course, the main result of this advance of the detached works was to increase the length of the perimeter which must be invested, and, therefore, the strength of the forces necessary to attempt a siege.

Since these detached forts were placed so far away from the main works and from each other, there was naturally considerable choice left as to these sites, and, in general, sites could be chosen having natural advantages, and the works would be specially designed for the site selected.

A typical example of these detached German forts is shown on figure 51, Plate XXXV. In general, the detached fort is in the shape of a bastion with long faces and comparatively short flanks, and with a reveted scarp across the gorge. The faces and flanks are fitted for heavy guns protected against enfilade by traverses and for infantry parapets between the guns. The faces along the gorge are finished as infantry parapets only. Ditch defense is provided by double caponiers at the salient angle and by single caponiers at the shoulder angles. An obstacle to assault is provided either by making the ditch wet or by a detached scarp wall built quite low but made sufficiently high to prevent escalade. In order to make access to the ditch difficult the counterscarp wall is made quite high. A somewhat similar French fort of the same period is shown on figure 52 on the same plate.

In the middle and latter part of this period there was a tendency led by the Belgian engineer, Gen. Brialmont, to the introduction of metal armor in land fortification, principally in the form of cast-iron turrets.

These cast-iron turrets were for four different purposes—direct-fire guns, mortars or howitzers, rapid-fire guns, and searchlights. The direct-fire guns used in these turrets were all front-pintled, rotating or revolving around a spherical band, fitted into the turret

PLATE XXXV.

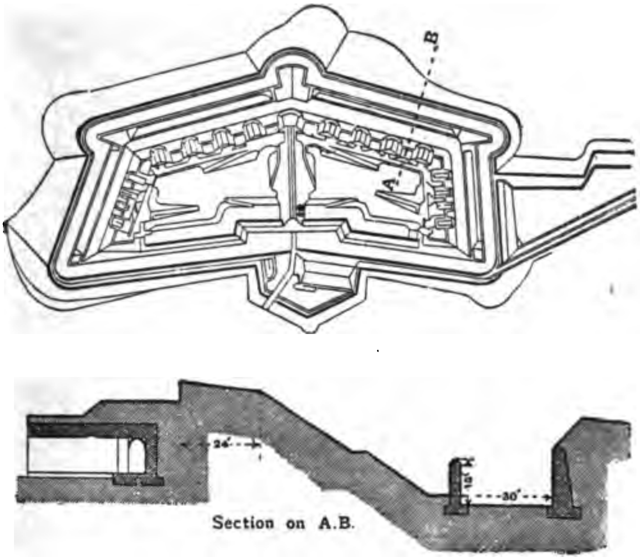


FIG. 51.—GERMAN FORT, ABOUT 1880.

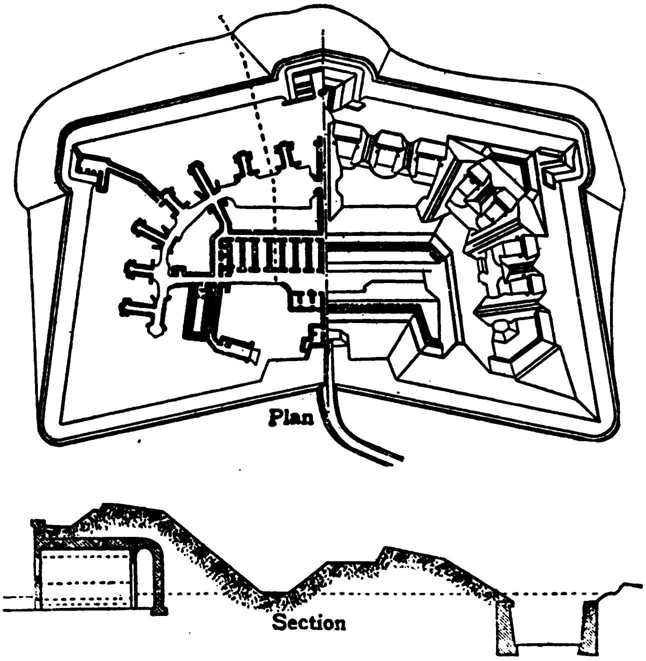


FIG. 52.—FRENCH FORT, ABOUT 1880.

From Encyclopædia Britannica, 1910.

PLATE XXXVI.

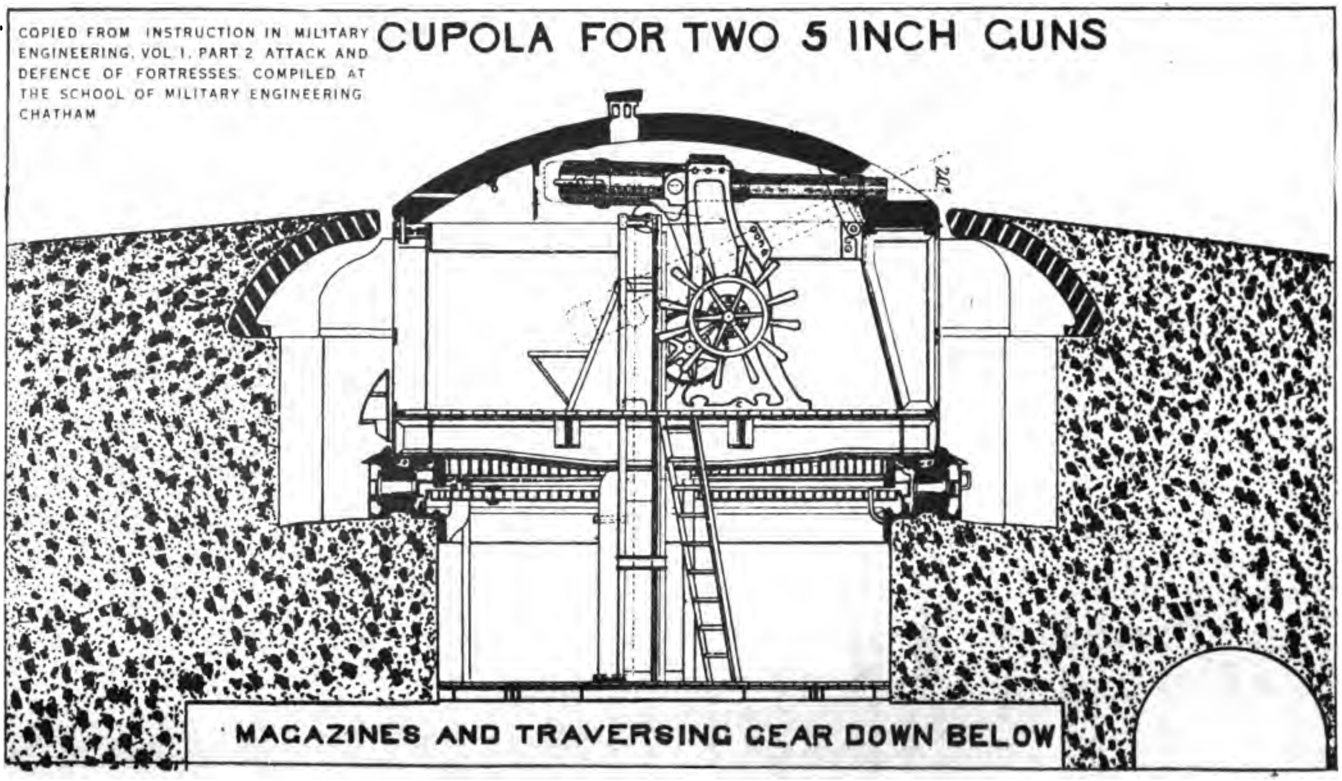
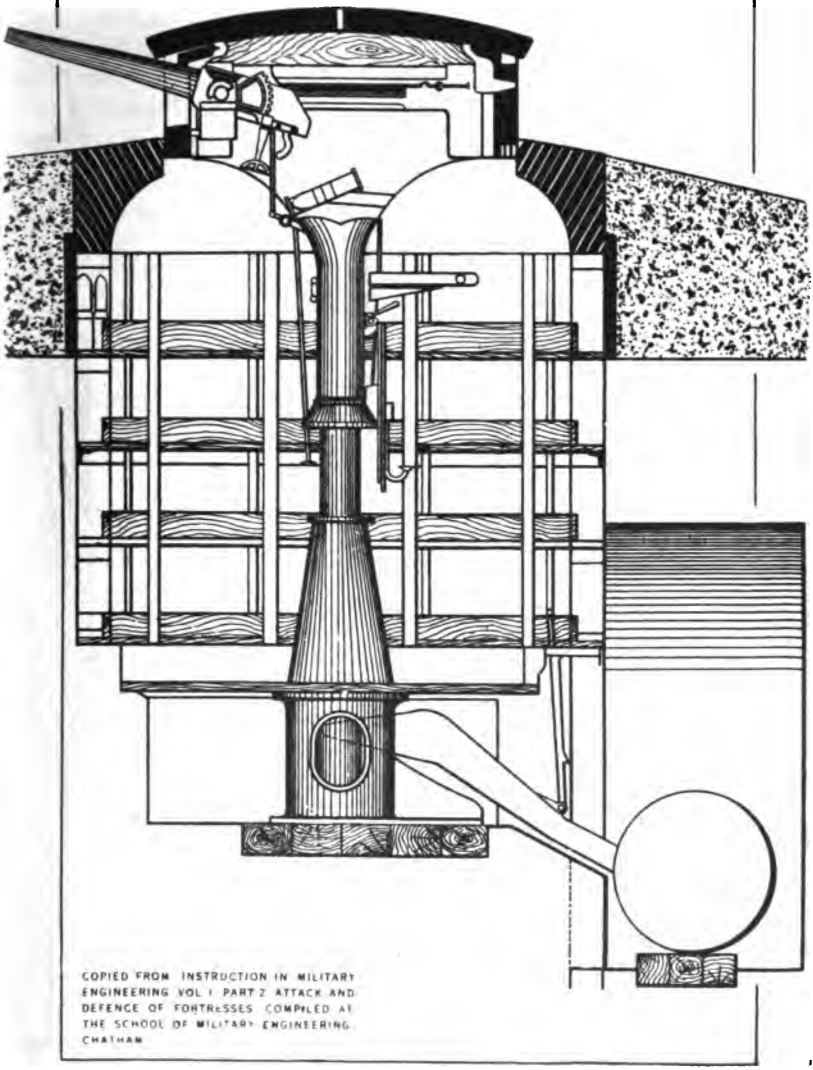

COPIED FROM INSTRUCTION IN MILITARY ENGINEERING, VOL. I, PART 2 ATTACK AND DEFENCE OF FORTRESSES. COMPILED AT THE SCHOOL OF MILITARY ENGINEERING CHATHAM
CUPOLA FOR TWO 5 INCH GUNS
20°
MAGAZINES AND TRAVERSING GEAR DOWN BELOW

FIG. 53.

PLATE XXXVII.

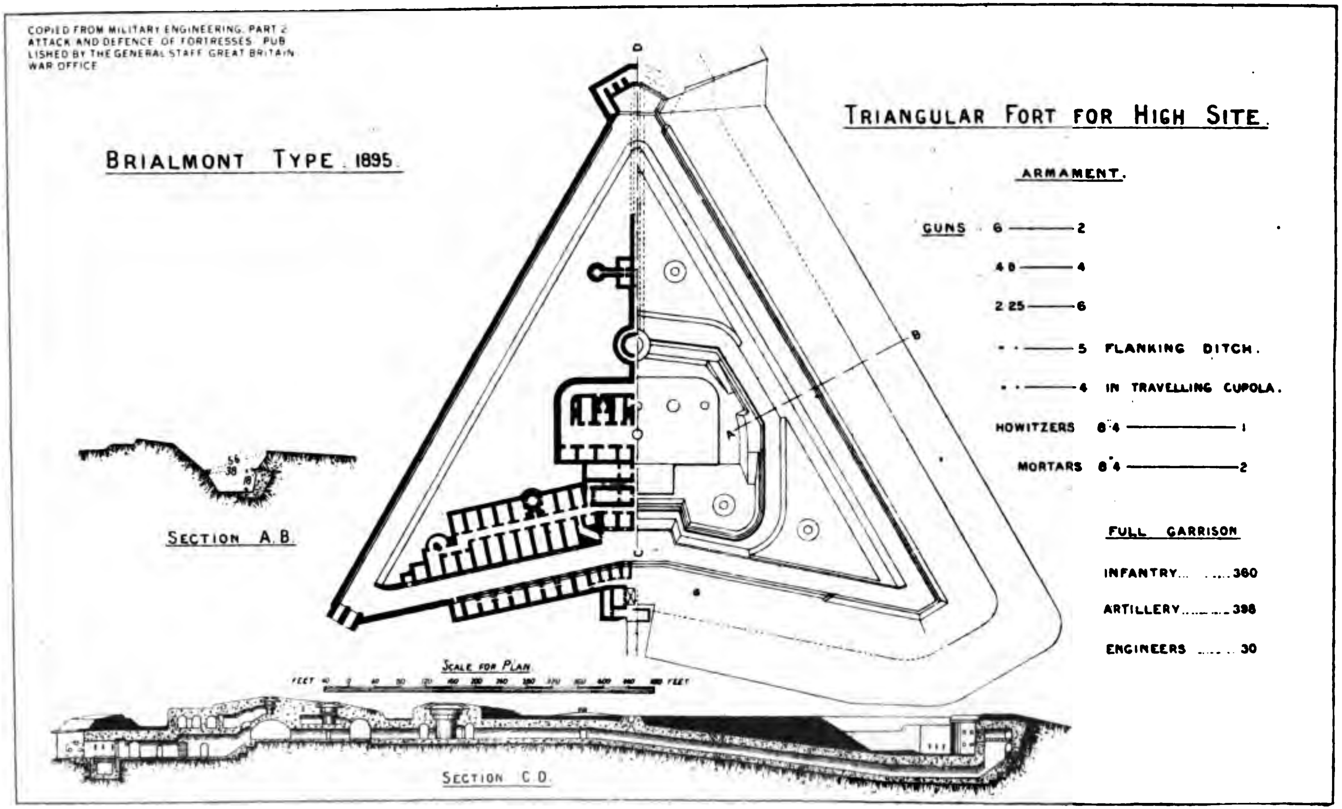
DISAPPEARING SHIELDED MOUNTING FOR 6^{PR} Q.F. GUN.



COPIED FROM INSTRUCTION IN MILITARY ENGINEERING VOL I PART 2 ATTACK AND DEFENCE OF FORTRESSES COMPILED AT THE SCHOOL OF MILITARY ENGINEERING, CHATHAM

FIG. 54.

PLATE XXXVIII.



COPIED FROM MILITARY ENGINEERING, PART 2 ATTACK AND DEFENCE OF FORTRESSES. PUBLISHED BY THE GENERAL STAFF GREAT BRITAIN WAR OFFICE

FIG. 55.

armor, near the muzzle of the guns (fig. 53, Pl. XXXVI). The mortars likewise were practically spherical in outline, pointing upward at any angle not less than 30 degrees through an opening at the top turret.

Similar turrets were utilized for searchlights and for small rapid-fire guns. In the last two cases, these turrets were disappearing, the entire turret with the gun or searchlight being lowered when not in use so as not to appear above the ground (figs. 54 and 55, Pls. XXXVII and XXXVIII).

The armor used in land fortifications was usually not as heavy as that used in seacoast fortifications. The seacoast fortifications were designed to combat battleships having turrets armed with 12-inch guns. The land defenses, however, were intended to combat such guns only as could be readily transported by the field army either over roads or on railroads. Since, at the time referred to, it was considered practically impossible to transport in this manner guns as large as 6-inch, the guns mounted in the turrets of the land fortifications were 6-inch guns only and the armor and concrete emplacements were designed to resist guns of this size only.

Consequently, when in the early part of the last war the Germans sprang a surprise on the military world and showed that they were able to transport readily 9-inch and 11-inch and even larger guns, vastly outranging the 6-inch gun of the Belgian fortifications, these large guns could be placed in position outside of the range of the Belgian guns and were enabled, before many hours had passed, to batter the armored turrets and the concrete emplacements out of existence.

In former times, when the cities were not large and when the defenses were built immediately around them, it was customary for most large cities, and almost certainly those near the frontier, to be fortified. When, however, it became necessary to abandon the old closed enciente method of fortifying towns, and to adopt the system of detached forts, the expense became so great that only those cities of great strategic or political importance could be fortified.

The area between the city proper which was fortified by this system of detached forts and the forts themselves formed a maneuvering area in which there could be assembled, trained, and maneuvered a comparatively large field army. In many respects, however, on account of the thickly built up character of the suburbs of a big city, the areas between a big city and the surrounding forts were inconvenient for mobilization or maneuvering, and it has therefore become the custom to choose some special area strategically situated and well adapted by the nature of the terrain for the training and mobilization of troops, and to make of it an entrenched camp, by surrounding it with a series of well-sited and carefully designed detached forts with lighter defenses between them.

These entrenched camps were intended for offensive purposes only, with the idea that the fortifications should protect the troops within them only until they could be properly trained and organized.

The modern system of cities or entrenched camps surrounded by detached forts is the latest system of permanent land fortifications. It should be noted, however, in this connection that the character of work in these forts and the character of the so-called field fortifications constructed in connection with this recent war resemble each other very closely. In both, earthwork is relied upon for the main protection, both include many bombproof magazines and shelters, and both make considerable use of concrete; both make use of the same kind of obstacles; and in the recent war, at least, both made use of guns of essentially the same character, so that at present there is practically no difference between permanent fortifications and field fortifications, except that the former are designed and constructed at leisure and in time of peace, and the latter somewhat hurriedly when the need arises.

SEACOAST FORTS.

During this period an almost revolutionary change took place in the character of construction used in seacoast defenses.

At the beginning of the period, the typical seacoast fortification was a closed work situated on the mainland or on an island, as close to the shore as possible so as to make the utmost use of the comparatively short range of the guns, and preferably located where the conditions of the navigable channels made it necessary for the passing vessels to come in fairly close. Occasionally, where the channel was quite wide, forts were placed on both sides so that any passing vessel had to come within comparatively easy range of one or both forts. Where the waterway was wider than a mile or so, its complete closure by land forts was not considered possible.

The forts themselves consisted of closed enceintes with high masonry scarps surmounted by earthen ramparts. On these ramparts were mounted guns as heavy as could be made at the time, the heaviest guns being placed close together on the sea fronts of the fort. On the land fronts, the guns, as a rule, were smaller and infantry parapets were frequently used. The ditches were usually dry, though wet ditches were used where possible. Outside of the ditches on all land fronts, typical land defenses were provided, consisting of a high counterscarp wall, a covered way, glacis, etc. In the larger works, outworks also were frequent.

On all sea fronts, the structures outside of the ditch were usually omitted so that the scarp walls were visible from the sea. In the scarps, at least one tier of casemate guns was usually provided so that with the guns mounted close together in barbette on top, a large volume of fire could be brought upon any ships coming within range. In a few places, such as Fort Wadsworth, on the western side of the Narrows at New York Harbor, stone works were constructed, having two or three tiers of casemates with a barbette tier on top.

Furthermore, as was stated in the preceding chapter, it was customary in most seacoast forts to have shot furnaces within which, when required, the shot could be heated so as to set fire to the wooden ship.

Against unarmored wooden ships, such seacoast defenses were extremely effective. They could not be silenced from the sea and could be captured by land attacks only. Furthermore, even after the invention of steam, it was only under the rarest and most favorable conditions that a wooden ship would ever dare to run by defenses of this character.

At the begining of the Civil War, the fortifications of our ports along the South Atlantic and Gulf coasts fell promptly into the hands of the Confederates, who immediately proceeded to improve them by increasing the number and size of the guns and by strengthening the defense on all sides.

Against these strengthened fortifications, there were, during the early years of the war, a number of naval demonstrations, all of which were unsuccessful, the wooden ships of the Navy never daring to anchor or to stay for any great length of time within range. Later in the war, the armored monitors became considerably bolder, and it was soon shown that their very heavy guns were able to do serious damage to the masonry fronts of such forts. However, the monitors themselves were not uninjured in such engagements, and the attacks were usually not pressed further than what might be called a demonstration in force. In fact, throughout the war, there was no case of a well-defended seacoast fort being captured by naval action only, the assistance of land troops being always required.

In the summer of 1864 Admiral Farragut decided to force his way into Mobile Bay past Fort Morgan, a typical fort of the character above described, and then to engage and destroy a small Confederate squadron in the bay, consisting of an iron-clad ram and a few gunboats. Fearing to risk his wooden vessels in the passage by the fort, he lashed on the port side of each of the leading wooden ships an iron-clad monitor, in order that the monitor might receive the low shots coming from the fort, and in this way protect the wooden ship from shots striking at or near the water line. This artifice was successful and by means of it, Farragut succeeded in getting his fleet past the forts with comparatively little injury, his principal loss being one monitor sunk by a mine.

The fort, however, was practically uninjured during this run by, and it was not until an army had been landed some miles away and had made a land attack that the fort surrendered.

Some of the most severe engagements which took place between ships and land forts during the Civil War occurred at Fort Fisher, near the mouth of the Cape Fear River, N. C. This fort consisted of large earthworks (there being no masonry scarps) mounting on the sea front a number of heavy guns. On the north side, the only one from which it was practicable to attack by land, the fort was strongly protected against a land attack. Fort Fisher was several times unsuccessfully bombarded from the sea, and once was unsuccessfully attacked by a combination of sea and land attacks. Finally, in January, 1865, another attack was made by a large fleet, assisted by a large landing force. The troops were landed under the cover of the fleet and proceeded to advance slowly against the fort by means of the usual land approaches. Upon a given signal the fleet came in and commenced a very heavy bombardment, the guns on shipboard outnumbering those on land by over 20 to 1, while at the same time a land assault was made on two portions of the land front. In spite of the disparity in the number of guns, the ships were beaten off with considerable damage to themselves, and but little to the fort. The land attack at one place was also repulsed with great loss. The other land attack was likewise apparently brought to a halt, and the garrison were resting from their labors when a portion of this land force succeeded by stealth in getting into the fort and in eventually capturing it.

The damage done to the masonry scarps by the armored monitors, and occasionally by distant guns on land where such was possible, showed conclusively that the masonry scarp on sea fronts must in the future be dispensed with, as had been the case centuries before on land fronts. Consequently, beginning shortly after the Civil War, all the new batteries built for our seacoast defenses had earthen exterior slopes, and no additional masonry scarps were built.

Beginning some six or eight years after the Civil War, and continuing nearly 20 years thereafter, seacoast fortification construction was almost abandoned in the United States, and before it was resumed—about 1890—a number of important developments had taken place. The breech-loading principle had been applied to all large guns and mortars, the older muzzle-loaders being completely done away with. The disappearing gun-carriages had been invented and had been shown to be a success. The breech-loading mortars had been shown to have sufficient accuracy for seacoast use and, consequently, mortars had come to be one of the principal elements of seacoast defense.

As a result of these new developments, the seacoast emplacements in the United States consisted either of direct-fire guns mounted on disappearing carriages in concrete emplacements, having thick sand parapets in front of them, and to a certain extent on top of their magazines, or of mortar batteries consisting of concrete mortar platforms placed behind concrete magazines surmounted and protected in front by heavy parapets of sand. As, however, the construction of such batteries is one of the most important of the duties of the Corps of Engineers, the details of construction are considered of sufficient importance to be the subject of a separate work and will not be further discussed here.

The use in seacoast defense of armored turrets has been given frequent consideration in this country, but it has been attempted but once—in connection with the fortifications of Manila Bay. It is understood, however, that turrets had been used to a considerable extent for seacoast defense abroad.

During the period when seacoast construction had practically ceased in the United States, a large British fleet containing several of the latest ironclads found it necessary to bombard the forts defending Alexandria, Egypt. These forts consisted of earthworks armed with cannon not of the most modern type. They were manned by comparatively indifferent troops, natives under a rebel commander. The British fleet bombarded these works for many hours, driving the defenders from their guns, and then sent a landing force ashore to take possession of the works.

Upon investigation it was found that although the guns had been silenced and a few of them injured, and a number of craters had been made in the earthwork, on the whole, however, the damage done was more apparent than real and a garrison of proper morale could have repaired much of the damage in a comparatively short time. Taking into consideration the fact that the fortifications on shore were by no means modern, that the ships were of the most modern type, that the disparity in the number of guns was extremely great, and that the troops on shore were untrained and undisciplined, it would appear that a similar attack against modern fortifications, manned by trained troops, would almost certainly have been unsuccessful.

During the Spanish War, the largest naval force that the United States had up to that time gathered together appeared off Santiago Harbor, Cuba, in which Admiral Cervera's fleet had taken refuge. The Spanish ships were completely out of sight from the sea, being hidden by high intervening hills. On each side, at the mouth of the harbor, the entrance being very narrow, were Spanish works. Imınediately at the entrance to the harbor were some old defenses over 100 years old, but on the hills some little distance at either side of the harbor the Spanish had hastily erected batteries with poorly built parapets. In general, the guns mounted in these batteries were of 6-inch or 8-inch caliber, and were exceedingly old, some as much as 125 years.

The only defenses that could be considered in the slightest degree modern were some six or eight guns which had been removed from a Spanish battleship which had been intentionally sunk in the harbor, and these guns had barely been emplaced when the American fleet started to bombard. For several days and occasionally at other times the Navy bombarded the forts. To the bombardment the Spanish made almost no reply, it being their custom to load the older guns at night and to fire them only once, if at all, the next day, and that without very careful aim or range finding.

After the surrender an inspection of the forts showed that in spite of the heavy naval bombardment, the damage done was trifling. Some bricks in the walls of the old fort had been knocked down and a modern steel lighthouse tower had been seriously damaged, but the only damage done to the defenses was the dismounting and destruction of two old bronze guns mounted on wrought iron, hand-made carriages.

CHAPTER X.

SUMMARY.

In the preceding four chapters the attempt has been made to trace briefly the changes that have taken place in fortification matters since the dawn of history, and to show that these changes have been due mainly to the increase in human knowledge and the development of the mechanical arts which from age to age gave birth to new weapons of constantly increasing power and efficiency. The subject has been treated in general terms only, and no attempt has been made to go into details, all questions of modern technique and detailed construction being left for treatment in separate works.

The importance of the alteration of the terrain so as to permit the movements of troops and military supplies, not only in the field but also within the limits of a defensive work, that is, in the offensive use of communications, has steadily increased with the size of the forces organized and with the increasing complexity of the impedimenta. In the very ancient days, when armies were small and could live on the country through which they passed, when the only weapons of the soldiers were those they carried with them, and no ammunition trains were necessary, the veriest trail sufficed as a communication. Now, in the day of large and complex armies, requiring the movement of large subsistence stores, heavy guns, and enormous quantities of ammunition, proper communications are essential. Then, so much of the art of fortification as related to the provision of communications was a simple matter and required but little forethought. It has now become extremely complex and requires much planning beforehand. The material needed for constructing the railroads and the rolling stock have to be obtained and brought to the place where needed, so that the very provision of means of transportation adds to the difficulty of the transportation problem.

The problem of providing protection against the missiles of an enemy has increased in difficulty with the increasing power and range of the weapons against which protection has had to be provided, and consequently there has been a gradual evolution in the character of protective works necessary. Against hand weapons and javelins a light stockade was sufficient. As the efficiency of the weapons was increased the means used for protection had to be increased also until at the present time against the modern gun thick masses of earth or of concrete are necessary. In the earlier days to be a few yards from the enemy was to be safe from injury by him. At the present time, in order to be safe from artillery, one must be nearly 100 miles away from the enemy, and even then safety from aircraft bombing presents a serious problem.

From the most remote ages it would appear to have been the custom of mankind, when congregated into large groups, to surround their dwellings by defensive works as a protection against individual or organized marauders. Under the unsettled conditions of ancient times, such defenses were absolutely essential to existence. During the early days of civilization the defenses of towns and cities were necessary, and even long after the reign of law and order had been generally established the walls around cities were found very useful.

In more recent years, the normal existence of peace and quiet has caused cities generally to outgrow their walls and to abandon the defensive works around them. In certain cases only, such as cities near frontiers or those of special strategic value, is any attempt at fortification now made.

As has always been the case, defensive works, however well planned and energetically defended, can of themselves accomplish no decisive results. Except when aided by extraneous circumstances and events, all they can do is to delay.

It is a fundamental rule that offensive action only can bring decisive results. Defensive action necessarily implies temporary or local weakness. All that it can do is to prevent the enemy, who is temporarily, or at least locally, the stronger, from accomplishing what he desires. Delays may prove fatal to his plans. Conditions in other fields of action may draw the enemy away, a relieving party may arrive, or the war may be settled elsewhere.

However, as has been noted quite frequently in this work, fortified towns and cities have often been able to hold out until a change of condition has caused the siege to be raised. In such cases, the fortifications have evidently fulfilled their functions and have paid for themselves.

Indeed, in many cases, even when the cities have been taken, the delays to the enemy before this was accomplished have been of great importance, permitting armies to be raised and allowing other things to happen that have had a decisive effect upon the results of the war or campaign.

Even during the recent war, the Belgian fortifications, which were destroyed with comparative rapidity by the Germans, may be said to have done a most useful work.

The Germans chose the route through Belgium into France because on the Belgian frontier the French fortifications were less strong than on the German frontier, and because it was well known to the Germans that the Belgian fortifications had not been kept up to date. They were built some twenty or thirty years ago in accordance with the fortification standards of that time. Their turrets, casemates, and other works were designed to withstand the field and siege guns of that day, and had become hopelessly outclassed by ordnance developments since that time. Consequently, when the German Army arrived before them, all that the fortifications were able to do was to delay the Germans until they could bring up their heavy artillery. This artillery, far outranging the Belgian guns, was emplaced out of range of the latter and, when ready, quickly battered the Belgian forts out of existence.

Since all the railroads from Germany through Belgium into France passed through one or more of these fortified towns, it was impossible for the Germans to use the railroads for supply purposes until the towns were taken. To be sure, the delay was not long, but short as it was, it was invaluable, for a few weeks later there came the crisis in France, when the question of whether or not the French and British could organize and bring up troops fast enough to withstand the onward rush of the Germans became a question not of weeks, but of days or possibly even of hours.

As a modern example of the important effect upon subsequent events of a failure to take a fortress, we have the case of Verdun in the recent war. This city was subjected to a terrific attack by the Germans, extending over practically an entire season. In the attempt at its capture the Germans expended enormous quantities of war material and sacrificed many lives. The French likewise made great sacrifices in its defense. It would appear that the strategic and military value of Verdun hardly justified the sacrifices made either by the Germans in the attempt to capture or by the French in holding the fort. By the operations on either side Verdun had been left at the apex of a pronounced and sharp salient and the French line would have been straighter and probably stronger had Verdun been abandoned, but when the Germans had once commenced the attack the loss of Verdun would have had a great depressing effect upon the morale of the French Army, and for this reason, the French were undoubtedly justified in holding on to it. Indirectly the operations about Verdun had a most important result for they gave time for the British to take important steps in the raising and organizing of troops. Had the energy displayed by the Germans in the attempt to capture Verdun been utilized farther to the west it would appear that the effects might have been disastrous.

From time to time within the last century books and articles have been written by military experts in which the attempt has been made to show that permanent defenses erected around a town or city are a waste of time and energy. These writers base their opinion upon an attempted analysis of military history. They put great emphasis upon active field campaigns, such as those of Napoleon, which were decided by field victories, after which the fortified towns fell promptly and, not infrequently, without any attempt at a siege. They claim that in many campaigns the existence of fortified towns has really been a detriment, in that their defense has required the defending general to detach troops from his field army and that not infrequently the refuge offered by these defenses has proved an irresistible temptation to the field army.

Recent writers even have gone further in this argument, using as a text the failure of Belgian fortifications to stop the advance of the German Army.

It is believed that these writers have misinterpreted history and have overlooked the many cases in which the successful holding of a fort or the delay necessary in capturing a city has had an almost decisive result on history. Especially has this been true where the city or fortress has been situated on an important line of communications, the possession of which is essential to the enemy. Nor is it believed that a careful analysis of history will show such a large percentage of successful sieges as is claimed by these writers.

In this connection, there are some things that must not be overlooked. In compiling matter for a history, or in actually writing a history, it is almost impossible for an author to avoid laying undue stress upon what may be called "the dramatic incidents." Similarly, the attention of the reader is apt to be impressed with such incidents and to overlook or soon to forget simple and unexciting occurrences.

When a city is captured after a long siege, there are always many incidents to attract the attention, both of the historian and of the reader; the near approach of the garrison to starvation until they have to resort to eating the most loathsome things; the bloody assault followed by the sacking of the town, the murder of the inhabitants, the mistreatment of the women. All these things give opportunities for vivid description and impress the memory both of the historian and of the reader, to a much greater extent than when a siege is unsuccessful and the attackers, despairing of success, slowly withdraw. When a siege is successful, the historian is liable to enlarge upon it, and when unsuccessful, he usually mentions only the fact and the reader soon forgets it.

Furthermore, there have been many cases when the presence of the fortifications and the evident difficulty of making a successful attack have deterred the enemy from attempting an invasion. It is inevitable that only in a very few such cases can the incidents ever become matter of historical record, but there have been thousands of them of which no record has been made. In fact, of both land and seacoast fortifications, it may be said that fortifications have most fully accomplished the purpose for which they were intended when by their very existence they have deterred the enemy from making an attack and therefore have actually never been called into use.

o

Again illustrating the difficulties attending lateral movement of troops and remembering the railroad bridge over the Meuse at Namur was not completed until September 30, we quote the Belgian Ministry of Defense (extracting from the Reich Archiv) (*54*):

> The lack of rail communications did have an adverse effect on the Battle of the Aisne. The XV Corps, notably, would have arrived earlier if it had been sent to Belgium via Namur-Brussels instead of through Liege; it could have been wholly engaged in that case with the VII Reserve Corps on September 13, whereas its first detachments only could intervene. Likewise, the I Bavarian Corps would have arrived on time at the scene of battle, if it had not had to detrain at Namur. One brigade of this corps crossed the river on foot at Namur and reentrained on the north side and was moved via Charleroi-Mons to Noyon. It arrived the afternoon of September 18 on the right of the First Army and reached the field of battle on the 19th, whereas it could have arrived 2 days earlier and been accompanied by the rest of the I Bavarian Corps if the railroad bridge at Namur had been available. The I Bavarian Corps, however, was obliged to march and did not arrive at its destination until September 23 in the region of Peronne. The XXI Corps which was also transferred to the right wing did not arrive near St. Quentin until September 22, because it had to move by Trier-Gerolstein-Aix-la-Chapelle-Liege. Finally, the II Bavarian Corps, whose trains followed those of the I Bavarian Corps, was obliged, like the latter, to detrain south of Namur and march by road; it did not arrive in the vicinity of Peronne until September 25.

E. RAILROAD DEMOLITIONS—SUMMARY AND OPINION OF AUTHOR

Both sides realized the tremendous strategic value of the main line railroads in the zone of advance and fostered definite plans for their control or destruction as the case may be.

On the Allied side, while plans did exist for the destruction of the lines in the event of invasion, only in the area around Namur and south thereof can their labors be said to have been highly effective. In the zone of the First Army, so feeble and ill-coordinated were the efforts that the Germans felt little shortage of supplies and were able to advance at the very impressive rate of 15 miles per day (*55*).

Only after the Marne, was any appreciable effect noticed in the right wing. This was the delay in the movement of the reserves shifted from the left to the right, and was caused primarily by the destruction of the Namur bridges and the Seilles tunnel.

It is the opinion of the writer that the errors in the execution of demolitions are, primarily, contained in the work around Liege. The commandant at Liege had roughly 6 days between July 29, when he started to clear his forts, and August 4, when the Germans crossed the Belgian frontier, to have thoroughly destroyed a number of bridges and tunnels between Aix-la-Chapelle and Liege. Till August 6 he could have destroyed the vital railroad bridge over the Meuse at Liege, and the steep viaduct and grade on the double track leading to the plateau above. Likewise, it is believed, there was ample time for the Belgian field army to have destroyed bridges on the retreat to Brussels.

Realizing that quite definite plans had been made prior to the war by the Belgians for demolition of strategically important structures, it is difficult to understand why the results were so mediocre. Per-

---

(*54*) No. 6, annex 14.
(*55*) No. 2, p. 26; No. 4, p. 2.

sonally, I believe this failure can be attributed to one of several or a combination of several factors:

(*a*) Lack of adequate means to accomplish the mission.

(*b*) Incomplete war plans.

(*c*) Lack of coordinated and intelligent direction and execution of the plans.

It is interesting to dwell on the hypothetical, and attempt to reconstruct what might have been the situation had the Aix-la-Chapelle-Liege-Brussels railroad been properly demolished. As a further conjecture, let us assume that the term "properly demolished" would be satisfied if at least 2 tunnels and 2 bridges between Aix-la-Chapelle and Liege, as well as the bridge and steep road bed in Liege and the side road through Herve were destroyed or rendered unserviceable. Based on data presented elsewhere in this study, it is probably safe to say that with the maximum conceivable rate of reconstruction, at least 30 days would be required before service could be resumed on the railroads. In other words no German train would have crossed the Meuse until after September 7.

From Liege to Mons, the distance measured in a straight line is some 100 miles. Granted that behind the German right wing was a formidable array of trucks; conceding that they could and would have selected the best routes, it is still my opinion that the First Army would have suffered a shortage of supplies at the Battle of Mons, which was fought August 23 (*56*).

One hundred and ninety miles from Liege and 160 miles from Namur lies the Grand Morin. On September 5, the German right wing reached there. Still considering the hypothetical demolitions outlined above, it is extremely doubtful that in 1914 motor trucks could have adequately supplied the right wing at such a distance from its railhead.

From these observations, however theoretical they may be, it is believed had the Belgians thoroughly demolished about one-third of the structures between Aix-la-Chapelle and Liege, the bridge and steep grade at Liege and a few structures between Liege and Brussels, the German right wing would have had to immeasurably delay their progress after Mons and should have been completely stopped at the Aisne by an inadequacy of supplies; the Battle of the Marne, as such, would never have been, but some such decisive engagement would have undoubtedly taken place further to the north.

(*56*) No. 14, p. 40.

BIBLIOGRAPHY

(*1*) Kuhl, von, and Bergman, von. (Generals, German Army): "Movements and Supply of the German First Army during August and September 1914," Command and General Staff School Press, 1929.

(*2*) Baills, Colonel: "Giberne de Sapeur," Revue Militaire Francaise, October 1932.

(*3*) Kretzschmann, Dr. Wilhelm Von, Formerly Major, German General Staff: "German Reconstruction of Railroads," The Military Engineer (July–August 1925), Vol. XVII, No. 94.

(*4*) Dumont, George A. L., Brigadier General, French Army: "Major Demolitions in Time of War," The Military Engineer, (January–February 1927) Vol. XIX, No. 103.

(*5*) Kluck, Alexander, Von, Generaloberst: "The March on Paris and the Battle of the Marne, 1914," Longmans, Green & Co., New York, 1920.

(*6*) Ministers de la Defense Nationale-Etat-Major General de l'Armee, Royaume de Belgique: "Defense de la Position Fortifiee de Namur en Acut, 1914," J. Havlange, Bruxelles, 1930.

(*7*) Poseck, M. Von, Lieut. Gen. and Inspector of Cavalry, German Army: "The German Cavalry, 1914, in Belgium and France," E. S. Mittler & Sohn, Berlin, for the U. S. Cavalry Association, 1923.

(*8* Somville, Gustave: "The Road to Liege," Hodder and Stoughton, London, 1916.

(*9*) Belgium, Ministry of National Defense: "Campaign of the Belgian Army July 31, 1914–Jan. 1, 1915," Translation in Command and General Staff School Library.

(*10*) Dane, Edmund: "Hacking Through Belgium," Hodder Stoughton, London, 1914.

(*11*) Galet, Lt. Gen.: "King Albert in the Great War," Putnam, London, 1931.

(*12*) Johnson, Douglas Wilson, "Topography and Strategy in the War," Henry Holt and Co., New York, 1917.

(*13*) Marchand, A.: "Les Chemins de Fer de l'Est et la Guerre de 1914–1918," Berger-Levrault, Paris, 1924.

(*14*) Howland, C. R.: "A Military History of the World War," General Service School Press, 1923.

(*15*) Robinson, Major Wm. F.: "Supply and Transportation, The German Campaign in the West, 1914," Manuscript in Command and General Staff School Library, 1923.

(*16*) Tappen, General de Division en Retraito "Jusqua La Marne en 1914," article contained in the book, "Documents Allemands Sur La Bataille de la Marne," Payot, Paris, 1930.

○

TC
1
U58

THE HISTORY AND DEVELOPMENT OF SOUNDING

with particular reference to

PRECISE SUPERSONIC-ECHO SOUNDING METHODS

as recently developed in the

U. S. ENGINEER DEPARTMENT

JULY 1940

NUMBER 73, OCCASIONAL PAPERS
THE ENGINEER SCHOOL, UNITED STATES ARMY

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ENGINEERS
U. S. ARMY

THE HISTORY AND DEVELOPMENT OF SOUNDING

with particular reference to

PRECISE SUPERSONIC-ECHO SOUNDING METHODS

as recently developed in the

U. S. ENGINEER DEPARTMENT

JULY 1940

NUMBER 73, OCCASIONAL PAPERS
THE ENGINEER SCHOOL, UNITED STATES ARMY

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1941

DEPOSITED BY THE
ITED STATES OF AMERICA
APR 23 '41

OCCASIONAL PAPERS, NO. 73

THE HISTORY AND DEVELOPMENT OF SOUNDING, WITH PARTICULAR REFERENCE TO PRECISE SUPERSONIC-ECHO SOUNDING METHODS AS RECENTLY DEVELOPED IN THE U. S. ENGINEER DEPARTMENT

Prepared under the direction of Lt. Col. H. B. VAUGHAN, Jr., *Corps of Engineers, United States Army*

The origin of depth sounding is clouded in the mists of antiquity, for it is a great deal older than any written history of which we now have knowledge. Certain it is that depth sounding was well known and commonly practiced in the days of the historian Herodotus, who in 450 B. C. (according to an old English translation) wrote "which is such that being in voyage to Aegypt, after you come within one day's sayling of the land, at every sounde of the plummet you shall bring up great store of mud and noysome filth, even in such places as the water is eleven ells in depth." In that day depth sounding was apparently a part of the navigating routine in the approach to the great city of Alexandria. It also seems quite probable that the lead or plummet was greased in order to bring up samples of the bottom for inspection.

In chapter 27 of the Acts of the Apostles we find an admirable account of a voyage of St. Paul. In A. D. 59 he was being carried as a prisoner to Italy in a ship containing "two hundred, three score and sixteen souls" and the ship was caught in a storm in the Ionian Sea. After days of buffeting about by the storm, after cargo had been cast overboard to lighten ship and hope had been abandoned, during the night the instinct of the crew told them "that they drew near to some country; and sounded, and found it twenty fathoms; and when they had gone a little further, thev sounded again, and found it fifteen fathoms. And fearing lest we should have fallen upon the rocks, they cast four anchors out of the stern, and wished for the day."

Strangely enough, in spite of the many advances of which our present-day civilization may be juestly proud, these ancient but direct methods of lead and line have remained the standard ones with little change and little improvement through more than 25 centuries. During the centuries of the Dark Ages, when science of all kinds was so closely allied to the mysteries of religion and so closely controlled by the highly organized religious castes, the hardy soul who would venture far beyond his own coast line was probably considered to deserve little aid or sympathy, and got none. The navigator of that day carried all of his knowledge literally "under his hat," for his navigational equipment as we know the term today was nil. His course was set by rule-of-thumb methods, including a fair share of superstition and folklore, knowledge of local landmarks, and more than a dash of shrewd guesswork. It is no wonder that most of the navigating was done close to shore. Later, by the crude lead-line methods in vogue, it came to be generally accepted that a depth of about 200 meters roughly marked a major nautical reference line, the limit between continent and the high sea. Here the bottom took a sheer drop, and then sounding became a problem because it was hard to "feel" the ocean bed. Beyond this was "blue water," where all must navigate by compass and stars until "the soundings" or the continental shelf was met again. The "blue water" region was cloaked in great mystery, and the term "perils of the deep," which occurs in many ancient writings, became stark reality, indeed.

During the nineteenth century the depths of the sea were becoming less of a mystery due to the courage and tenacity of some of the hardy explorers. Soundings of a sort were made in depths which had hitherto been termed unfathomable, and one known effort inevitably led to others. Lt. Matthew F. Maury, "The Pathfinder of the Seas," in his book, the Physical Geography of the Sea, published in 1855, cites numerous examples of deep-sea soundings, both his own and others. Captain Denham, of the British warship *Herald*, in 1852 took a sounding of 7,660 fathoms in latitude 36°49′ S., longitude 37°6′ W. where more recent and reliable soundings have shown but 2,734 fathoms. In 1858 Captain Pullen, of H. M. S. *Cyclops*, wrote of taking soundings and bottom samples at 2,700 fathoms and complained of the time consumed in reeling out the sounding line and taking it in. He further complained about the uncertainty of feeling the sea bottom when it was attained.

Lieutenant Maury explains this uncertainty in these words:

> All of these attempts were made upon the supposition that when the lead reached the bottom either a shock would be felt or the line, becoming slack, would cease to run out.
>
> The series of systematic experiments recently made upon this subject shows that there is no reliance to be placed on such a supposition, for the shock caused by striking bottom cannot be communicated through very great depths. Furthermore, the lights of experience show that, as a general rule, the undercurrents of the deep sea have force enough to take the line out long after the plummet has ceased to do so. Consequently, there is but little reliance to be placed upon deep-sea soundings of former methods when the depth reported exceeded eight or ten thousand feet.

In 1836 Ericcson patented a self-registering lead which appears to be the first indirect depth-sounding method which ever reached that stage of development. It was a pressure method based upon the raising of a column of salt water in a glass tube by the compression of air in a pipe or hose lowered to the bottom. The glass tube was coated with silver chromate which was changed in color from orange to white (silver chloride) as it came in contact with the rising water column. There are a number of reasons why the method never attained any great vogue at that time. It is obvious that much uncertainty in determining great ocean depths was due to having no definite indication of when the bottom had been reached. Many schemes were put forward for overcoming this difficulty and some were quite ingenious. Perhaps the most practical schemes included a heavy weight and a light but strong line to which the weight was attached in such a way that it would automatically be released upon touching the bottom. Then the line could be reeled in more readily and measured as it was reeled. Improvements on this idea soon included a small sampler to bring up a bottom sample for study. Shortly before 1880 Capt. C. D. Sigsbee, of the United States Navy, devised the Sigsbee deep-sea sounding machine, which constituted a major advance of the time in the art of depth sounding. This device consists of a reel containing some 1,500 fathoms of piano wire, a steam hoisting engine, a pulley, a tension controller which maintains fairly constant strain on the wire and also shows when the tension sharply decreases at the instant that the weight contacts the sea bottom. It also included a counter to register the length of wire run off the reel and finally a sounding rod (sampler) with a detachable weight. Except for minor improvements, such as substituting an electric motor for the bulkier and slower steam hoist, the Sigsbee device still stands as about the ultimate of its class. Some of these improved types, both manually and power operated, which are in use today by the United States Coast and Geodetic Survey, the United States Engineer Department, and the British Admiralty will be discussed in a later section, together with brief comments on other direct methods with poles, sweeps, and drags.

Any account of the depth-sounding activities of the time would be far from complete without mention of the work of Lord Kelvin, the versatile and brilliant English scientist. He developed an indirect method which enabled the navigator to obtain soundings while under way, by enclosing a pressure-sensitive device within the lead to record hydrostatic pressure. When sufficient line was reeled out so that the lead touched bottom the small pressure-responsive element registered the maximum pressure attained, which was a function of the depth at that point and had no relation to the length of line unreeled. This device was generally known as the Thomson sounding machine, and in spite of its apparent advantages its operation was costly as well as time consuming, because it still required physical contact with the sea bottom.

Not so well known but quite ingenious are Arnoldi's continuous sounding pole of about 1882 and the submarine kite of Samuel H. James about 1891. These devices will be explained in some detail later.

No doubt we have all noted the phenomenon of echoes in air, and perhaps as children we have derived much innocent amusement from shouting across at a high cliff and waiting for the sound of our voice to return. For many years echoes in air have been put to practical use by navigators the world over, notably by those in the fiords of Norway and upon some of our own great rivers, as an aid when visibility is poor. By blowing a whistle or a horn and counting the time until the echo is heard, at a sound velocity of about 1,100 feet per second, they have a working knowledge of their distance from cliffs or high banks on shore. However, few of us realize that the same phenomenon takes place in water but at a much faster rate due to the greater density of the medium involved. Sounds in water travel at the rate of about 4,800 feet per second, whereas the rate in air is only about 1,100 feet per second, a ratio of approximately 4½ to 1. Fortunately for the various applications of sound in water, including hydrographic surveying, sound velocity varies but slightly from season to season and from place to place due to changes in temperature, content of dissolved solids, and pressure. Where there are such variations, their magnitude can be measured and due allowance made in survey work.

Despite the fact that for centuries sound has traveled through water and has been reflected or echoed from obstacles in its path, it has only been since the early nineteenth century that the possibility has been suggested. By some authorities Leonardo da Vinci (1452-1519) is credited with being the first to notice the transmission of sound in water by dipping the blade of an oar in the water and holding his ear against the end of the shaft. Whether this be fact or myth is not so important as is the fact that no further interest was taken in the matter for some 300 years.

Thanks to the vision of the brilliant French physicist and astronomer, Dominique Francois Jean Arago, an indirect method of depth measurement was proposed in 1807, but again apparently little interest was evident.

Then in 1827 two scientists, Collodon and Sturm, carried on a series of experiments on the velocity of sound in water. In Lake Geneva they equipped two boats and moored them a measured distance apart. On one boat an observer struck a bell which was fastened to his boat below the water line and at the same instant he fired a charge of gunpowder into the air to provide a visual signal. The observer in the other boat noted the gunpowder flash and timed from that instant until he heard the sound of the gong under water. Thus was one step taken on the long road toward practical application. Years later, and apparently quite independently, in this country Lt. Matthew F. Maury, one of the truly great pioneers of his time, in 1854 fired gunpowder charges beneath the water and listened for echoes from the sea bottom which he never heard. To gain a better idea of how far Maury was thinking ahead of his contemporaries let him tell the story:

> Attempts to fathom the ocean, both by sound and pressure, had been made, but out in "blue water" every trial was only a failure repeated. The most ingenious and beautiful contrivances for deep-sea soundings were resorted to. By exploding petards or ringing bells in the deep sea, when the winds were hushed and all was still, the echo or reverberation from the bottom might, it was held, be heard, and the depth determined from the rate at which sound travels through the water. But, though the concussion took place many feet below the surface, echo was silent, and no answer was received from the bottom.
>
> Ericcson and others constructed deep-sea leads having a column of air in them, which by compression would show the aqueous pressure to which they might be subjected. This was found to answer well for ordinary purposes. but in the depths of the sea, where the pressures would be equal to several hundred atmospheres, the trial was more than his instrumments could stand. Mr. Bauer, an ingenious mechanic of New York, constructed, according to a plan which I furnished him, a deep-sea sounding apparatus. To the lead was attached, upon the principle of the screw propeller, a small piece of clockwork for registering the number of revolutions of the little screw during the descent; and, it having been ascertained by experiment in shoal water that the apparatus, in descending, would cause the propeller to make one revolution for every fathom of perpendicular descent, hands provided with the power of self-registration were attached to a dial, and the instrument was complete. It worked beautifully in moderate depths, but failed in blue water, from the difficulty of hauling it up if the line used were large enough to give the requisite strength for hauling it up.
>
> An old sea captain proposed a torpedo, such as is sometimes used in the whale fishery for blowing up the monsters of the deep, only this one was intended to explode on touching the bottom. It was proposed first to ascertain by actual experiment the rate at which the torpedo would sink, and the rate at which the sound or gas would ascend, and so, by timing the interval to determine the depth. This plan would afford no specimens of the bottom, and its adoption was opposed by other obstacles.
>
> One gentleman proposed to use the magnetic telegraph. The wire, properly coated, was to be laid up in the sounding line, and to the plummet was attached machinery, so contrived that at the increase of every hundred fathoms, and by means of the additional pressure, the circuit would be restored, somewhat after the manner of Dr. Locke's electrochronograph, and a message would come up to tell how many hundred fathoms up and down the plummet had sunk. As beautiful as this idea was, it was not simple enough in practical application to answer our purposes.

Today we know that if Maury had used the oar of Leonardo da Vinci, if he had one of our modern hydrophones, or even if he had held his ear under the water, the echo came up to be heard.

The disaster of the *Titanic* sinking on April 15, 1912, after collison with an iceberg, turned the thoughts of many people to ways and means of preventing such disasters in the future. Among these, Richardson, in England, proposed the use of sound waves of higher frequency than the ordinary human ear can detect. Such sound waves have been termed "supersonic" or "ultrasonic." Richardson knew no other way to produce these waves but mechanically, so he proposed a hydraulic whistle to be placed at the focus of a reflector shaped like a segment of a sphere. The method was unsuccessful, as the sound projector was lacking in power. At about the same time Sir Charles Parsons, of England, attempted to use a hydraulic siren as a sound generator under water but without success.

After years have elapsed it is frequently difficult to determine priority in the conception of ideas and in putting those ideas into a practical and workable form. At this time, however, it seems to be nearly certain that sonic sounding as we know it was made a practical possibility by Dr. Alexander Behm, the Austro-German physicist, at Keil. His work on the problem started also after the *Titanic* disaster, and if the results insofar as icebergs are concerned have not been entirely conclusive they have certainly laid much of the groundwork for the science of acoustic depth measurement. When Dr. Behm started to work on the problem it was not known with any degree of certainty that such a thing as an echo in water even existed. Ignorance of this fact, which persisted for so many centuries, is perhaps in large measure due to the high velocity of sound in water. This high velocity causes the echo over short distances to return so rapidly as to merge with the initial or projected sound and thus be indistinguishable from that sound. Ironically enough, this same problem of measuring extremely small time intervals with great precision still remains perhaps the most stubborn one to be overcome. It is rendered doubly difficult by the great difference between laboratory and shipboard facilities. Dr. Behm projected his sounds in a small tank and then photographed the sound waves as they were reflected from the sides and ends of the tank, from the surface of the water, and from various objects placed in the water. His experimental tank was about 11 by 10 by 5 inches over all, and if we compare these small dimensions with 4,800 feet per second, the velocity of sound in water, we will have some conception of the problem which he had assumed.

When in 1912, by an adaptation of the Einthoven string galvanometer, he had shown by experiment in Heikendorf Bay, near Kiel, that the bottom of the sea would return an echo, a momentous step had been taken. Great as that step was, the road was still long and tortuous before the echo depth sounder became a commercial instrument capable of providing accurate and dependable depth readings day in and day out for navigation and hydrographic survey use.

In addition to a means of generating the under-water sound and a receiving device to detect the echo, Behm's first equipment also included a double galvanometer, with its associated photographic apparatus for making and developing the record, and a tuning fork for marking a time trace on the record. The developed record then showed the trace of sound emission and echo return, which by comparison with the time trace could be translated into terms of depth. The apparatus was not only unwieldy for shipboard use but Behm soon found that measuring short time intervals accurately was so difficult that he temporarily abandoned the method in favor of an intensity method.

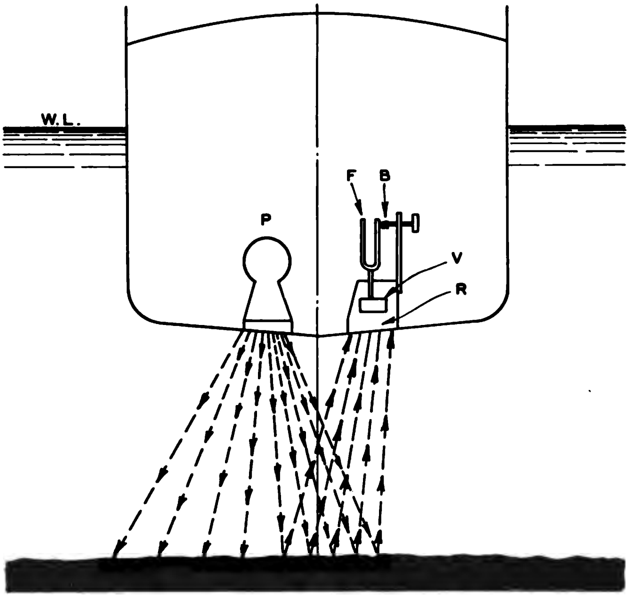


FIGURE 1.

The principle upon which this sound-intensity system operated is shown diagramatically in figure 1, which roughly represents a section of a vessel. *P* is a submarine sound generator which will produce a sound of constant pitch and intensity and project that sound through the hull or a diaphragm in the hull into the water and toward the bottom. A portion of this projected sound strikes the sea bottom, and some of it is reflected or echoed back toward the water surface. That portion which strikes the diaphragm of the resonant chamber *R* will cause vibrations within the chamber and set the vane *V*, and thus the tuning fork *F* into vibration. The amplitude of the vibration of fork *F* is a measure of the intensity of the sound received, and this amplitude can be measured by observing the movement of the small index *B* on the fork. This measurement can be made with a suitable microscope and scale. Since the intensity of the echo, as indicated by the amplitude of fork vibration, is a function of the depth of water under the projector, the microscope scale can be calibrated directly in depth.

While the method does avoid the difficulty of measuring short time intervals, it falls heir to other troubles, some of which are quite as serious. Problems of maintaining constant intensity and pitch in the projector and of keeping the receiving unit tuned closely to this pitch and of holding constant sensitivity under all operating conditions are not small ones. The greatest difficulty appears to be the fact that the intensity of echo is not entirely a function of depth but also of the coefficient of reflection of the bottom. This factor is not only important but it is subject to large variation from place to place within small areas. Compensation for such an intangible variable presents a problem which almost defies solution within the limitations imposed by navigation and survey conditions. It is probable that Dr. Behm decided on the lesser evil of time-interval measurement, for he returned to that method in his later work. This work resulted in the development of the Behm-Echolot system now in use, which will be described in greater detail later. It was probably also the *Titanic* disaster which led Prof. R. A. Fessenden to experiment with his submarine oscillator in order to detect the presence of icebergs near vessels. This device, shown in figure 2, is in effect an electrical

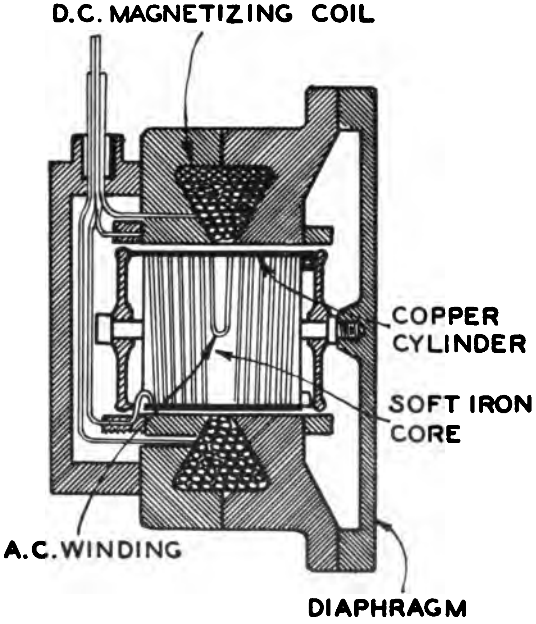


FIGURE 2.

transformer the secondary winding of which floats in a strong radial magnetic field. Near the secondary winding the primary is wound on the pole face of the electromagnet. This winding is made of but one turn of copper (a cylinder) for low electrical resistance, so that the current through it is large and it therefore exerts a large force. As the current alternates, this cylinder is subjected to alternating forces of considerable magnitude. Due to its freedom of motion these forces are transmitted directly to the steel diaphragm in contact with the water. The amplitude of the diaphragm at resonant frequency is very large, and as a sound transmitter is it quite efficient.

The device can also be used as a receiver of sounds of resonant frequency, and in this case the process is the reverse of that outlined. The vibrations of the diaphragm move the copper cylinder, inducing small electromotive forces in it and thus in the secondary winding on the pole face. This electromotive force is amplified and then actuates headphone detectors or some type of indicating device.

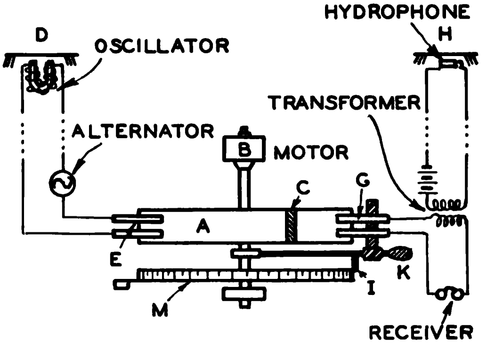


FIGURE 3.

The indicating device used with the oscillator in the iceberg-detection experiments was constructed as shown in figure 3.

The governed motor *B* drives disk *A* (which is made of insulating material) at a constant speed. On the edge of this disk is a conducting segment *C* which short-circuits the sliding contacts *E* and thereby energizes the Fessenden oscillator *D*, sending a short sound impulse into the water. As disk *A* continues to rotate, segment *C* completes the circuit between contacts *G*, closing the circuit through the telephone receiver. If at this instant the echoed impulse from the iceberg reaches hydrophone *H* an echo will be heard in the receiver. When these conditions prevail, the time taken by the oscillator impulse to travel to iceberg and back to the ship will be exactly equal to the time consumed by the rotating disk in its travel from contacts *E* to contacts *G*. This time interval will be indicated by the position of index *I* on the scale *M*, which is firmly attached to the same shaft with disk *A*. The angular position of index *I* and contacts *G* can be shifted at will around disk *A* by means of handle *K* until a position is found where the echo is heard in the receiver.

In practice this indicating device gave some confusing results and thus never passed the experimental stages. However, during the tests Professor Fessenden had occasion to apply the apparatus to sounding the ocean bottom, and the results obtained were encouraging enough to warrant further work in this field. Echoes from icebergs were heard at a distance of 2½ miles and signals transmitted through the water were heard at a distance of 34 miles. Soundings of 36 fathoms were checked with a lead line at 31 fathoms.

It should be noted here that in the work of both Dr. Behm and Professor Fessenden sound waves of sonic frequencies were used. Sonic frequencies are those which the normal human ear can detect unaided. The upper limit of sonic frequency is about 20,000 cycles or periods per second, although most ears are insensitive to much lower frequencies, and generally other forms of detection are employed.

The work of both Professor Fessenden and Dr. Behm in the field of echo sounding seems to have been diverted into other channels during the World War, so that it was not until after that period that active work in this field was resumed. However, due to the intensive war activity in submarine detection, under-water signaling, and work of that nature, echo-sounding technique had advanced by leaps and bounds and the new science resumed at a faster tempo.

In the further consideration of the various sounding methods in order to avoid confusing the many types which have appeared in recent years, it is deemed desirable to discuss them according to the fundamental principles involved in each.

DIRECT-SOUNDING METHODS

Sounding methods are classified as direct when direct physical contact must be maintained with the bottom at the time that the measurement is made.

I. *Sounding-pole methods* (fig. 4).—The method of sounding with a pole or rod is probably as old as civilization itself, and yet the method has continued through the ages with few changes. It is inherently adapted to work in shoal water, and today it still has many applications in that field. The rigidity of the pole gives it a decided advantage over a flexible line, and when a disk is attached to the lower end the avoidance of overdepth measurement is also in its favor. However, poles of any length are bothersome to handle, and work with them is necessarily slow.

There are at least two variations of the sounding-pole method of which some details are known.

Of these one was devised by Mr. John R. Arnoldi, of Ottawa, Canada, about 1882.

The fundamentals of the method are shown in figure 5.

A is a weighted pole or rod pivoted at *P* and attached to index *E*, which traverses the scale *D* as the depth of water beneath the boat varies. The pole has a heavy metal shoe at the lower end shaped so as to slide over bottom projections. Line *B* is attached to the shoe and to a reel so that the pole can be raised when not in use. The index may be offset on the scale for the height of the pivot point above the water surface, and then depths can be read directly from the scale for all depths within range of the pole.

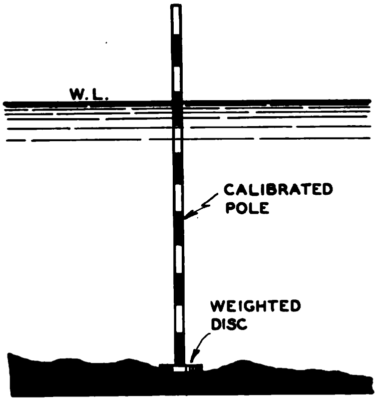


Figure 4.

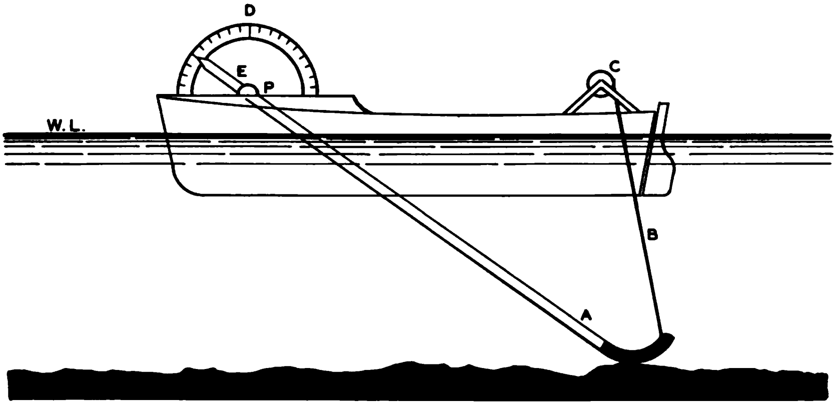


Figure 5.

The other was conceived in 1902 by Maj. C. McD. Townsend, Corps of Engineers, then district engineer stationed at Rock Island, Ill., on the upper Mississippi River. The details of the device were worked out by Mr. Montgomery Meigs, a civilian engineer in the district, and the machine was still in active service there as late as 1928. It was constructed upon a special barge having an open well in the center through which a pole projected. The lower end of the pole trailed along the bottom and the upper end was connected to a suitable recording apparatus mounted in an enclosure on the barge deck. Figure 6 will give a general idea of the construction. It was soon found that the weight of the pole alone, especially in deeper water, would not keep the foot in contact with the bottom without an additional device to counteract the upward thrust of the current when the barge was moving forward. The vanes were then attached, and when set at the proper angle they kept the end of a 36-foot pole on the bottom at 22 feet depth under all working conditions. The barge was pushed ahead of a towboat and was designed primarily for use at low river stages when depths of 7 feet or less were usual on bars.

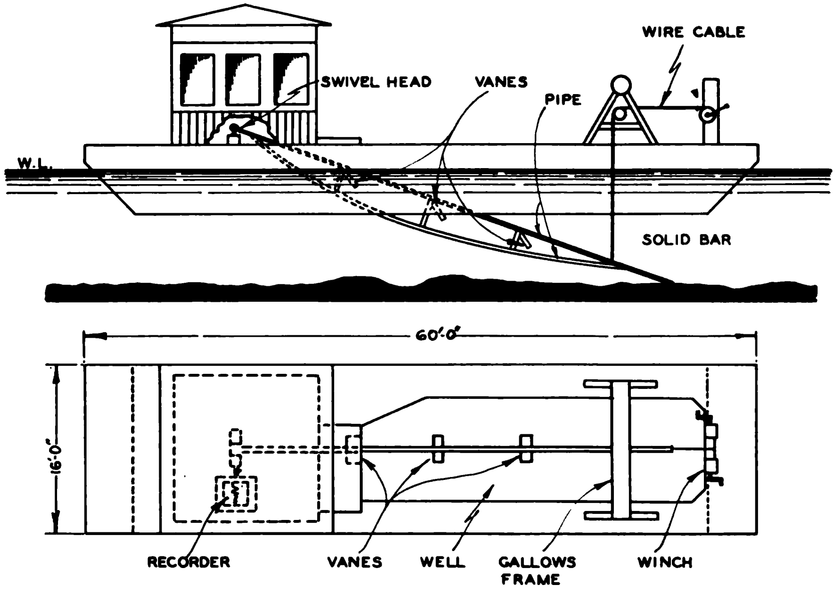


FIGURE 6.

The motion of the pole was transmitted to the recorder by means of a belt running in a sharply grooved pulley or quadrant on a horizontal shaft attached to the head of the pole in the deck inclosure. A system of belts and pulleys was so arranged as to pull a recording pencil in a reciprocating motion, as depth varied, while the paper drum slowly revolved at right angles as a function of time (or roughly forward motion of the barge). The depth is equal to the product of the pole length and the sine of the angle made by the pole with the horizontal. To get the net depth it was necessary to subtract from this a constant equal to the vertical distance from the swivel head to the water surface. This amounted to an offset at the zero end of the depth scale. The recorder drum was clock driven, and a weight-driven reroll device was incorporated to rewind the finished chart without adding any load for the clock to pull and at the same time to provide for variable roll diameter. The paper was made with perforations at each side, and fixed pencils were located along a bar to mark the depth calibration lines as the paper passed under the bar.

Before taking soundings the pole was set at the water-surface position by raising it with the winch at the stern. At this position the zero pencil was set for chart zero.

In operation an observer was seated at a table before the recorder in the deck cabin, with a good view on all sides. As range markers or other shore objects were passed he marked them on the chart for reference. In this way the location of shoal spots was closely fixed.

Figure 7 is a reproduction of three sections of depth chart as made by the apparatus described. It has been claimed that not only did the pole emit characteristic sounds for the different bottom materials over which it passed but that the depth record displayed certain characteristics by which the type of bottom could be identified. Referring to figure 7, *A* is noted as rock bottom, *B* gravel, and *C* as sand. At *D* are large sand waves displaced by contractor's equipment working in the river above and not at the time absorbed or dissipated by the flow. At *E* is a snag, at *G* the pole is beyond its depth and floating, and at *H* is a broken line where a check was made with hand-pole soundings.

For the type of service noted it is difficult to understand why this type sounding apparatus was not more generally used.

II. *Hand-lead-line methods.*—That the hand-lead-line has abundant historical background cannot be denied, but undue accuracy must not be attributed to the method for this reason. Those accustomed to taking soundings with the lead-line are sometimes prone to overrate its accuracy because of the feeling of confidence which physical contact with the bottom gives them, and this attitude is also fraught with danger.

Unfortunately, in hydrographic surveying the dangers resulting from such overconfidence are seldom immediately apparent, but they are nonetheless real.

In former times the sounding line was made of ordinary rope, which stretched and shrank as it was wet or dry and as it was subjected to the tension of the lead or allowed to dry under no tension. More recently, and particularly for hydrographic work, a braided rope having a stranded wire core of phosphor bronze has become the standard for all work having any claim to accuracy. The wire core in some instances has been termed a Kelvin wire heart. Even lines of this type are subjected to several alternate cycles of soaking and drying under tension before they are finally calibrated for use.

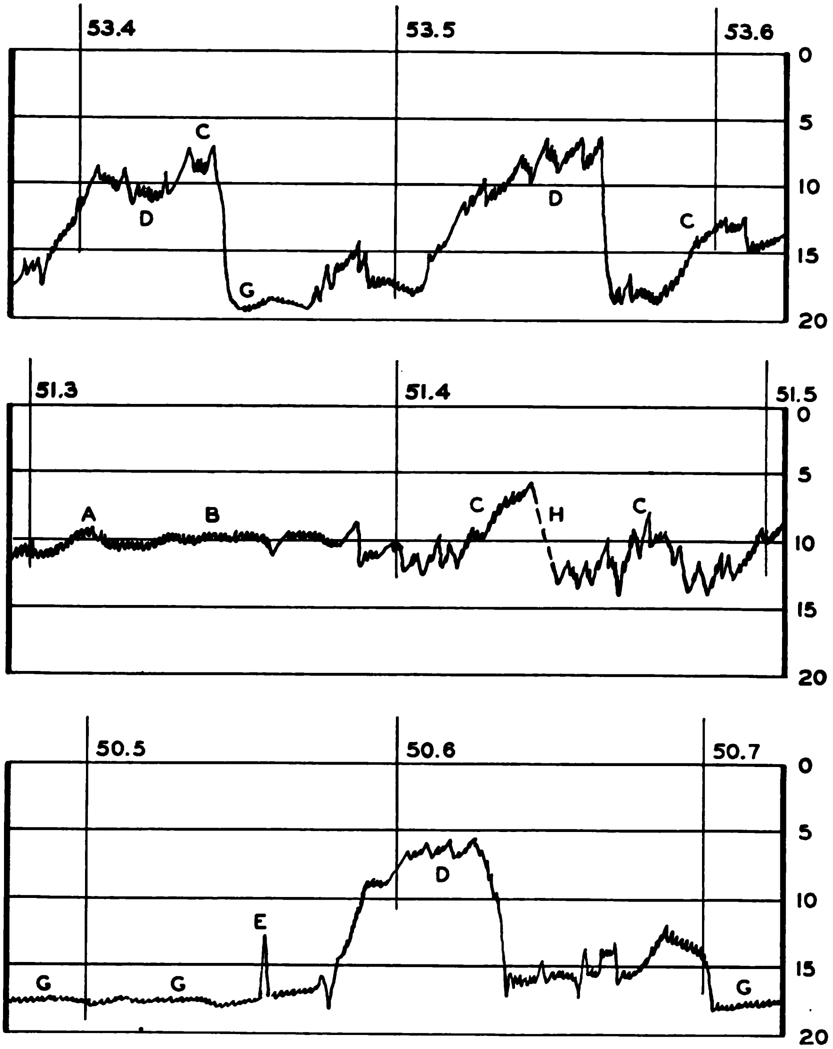


Figure 7.

Sounding leads vary in weight and shape with the type of work for which they are used. The lead for ordinary casting is shaped like a truncated cone, with the smaller diameter end attached to the line. Weights vary from 8 pounds to 10 or 12 pounds, depending upon depth of soundings. In river work, where currents attain considerable velocity, heavier leads are often used in order to insure a more nearly vertical line.

Soundings must be taken from a vessel moving so slowly as to barely maintain steerage way. The leadsman, located in the sounding chair, heaves the lead far enough ahead so that it will reach the bottom just when his position is directly above that point. Then he pulls the line taut, and at the instant when he is directly above the lead, he lifts it just clear of the bottom, lowers it quickly, and as it again touches bottom he reads the water level on the line. The important part is that slight lift and drop of the lead so that both lead and line will be vertical at the moment. Then the line is hauled in and coiled for the next cast.

A good leadsman will instinctively keep enough line in his hand-coil for the depths that he is sounding at the time, and also experience alone will teach him how to read average depth on his line in choppy water. The importance of experience and sound judgment in a leadsman's work makes it distinctly a skilled job. Sounding with a hand lead is impracticable when such depths are reached that the vessel cannot maintain steerage way without overtaking the lead before it touches bottom. Various fore-and-aft trolley arrangements have been devised to overcome some of the objections to hand-lead methods, but they generally require more men and a longer sounding interval, so that they have seldom met with much success.

In 1900 F. C. Shenehon, an engineer of the Lake Survey District of the United States Engineer Department, devised a method, termed the static method, by which he mathematically compensated for the bow or catenary in the sounding line due to water velocity on the surface and in substrata. The compensation is based upon the magnitude of the angle that the lead lines makes with the vertical, and tables of sounding corrections have been computed. The method has proved satisfactory for limited survey use from a moving boat in depths to 100 fathoms. The weights of 140 to 600 pounds used and described by Shenehon are not well adapted to portable use. In any event a so-called static sounding is an approximation, as indeed all measurements are in a literal sense. Under conditions of high current velocity and great aeration, such as the rapids of the Niagara River below the Falls, the static method has much to recommend it.

For work in shoal waters in rivers and harbors various types of leads with wire lines reeled upon wheels are in quite general use. These may be manually or power operated. The wheel in most general use is of known circumference with a spiral slot in the rim. Piano wire is wound on the wheel, the lead attached, and a special counter geared to the wheel is set on zero at the water surface. The whole mechanism takes but little space on the boat and may be fastened in place where desired. Although the wire offers less resistance to the water than does the wire-core rope, sounding-wheel measurements are generally taken with the boat drifting.

Sounding wheels of special design have been used particularly in some areas along the Mississippi River to enable the engineers to get depth data rapidly and with the required accuracy.

Figure 8 shows a manually operated sounding wheel mounted on a skiff. Figure 9 shows another sounding wheel, power operated with clutches, brakes, etc., and turntable mounting for taking so-called "circle soundings," which are of considerable value in certain river revetment work. These wheels both include the indicating counter mechanism.

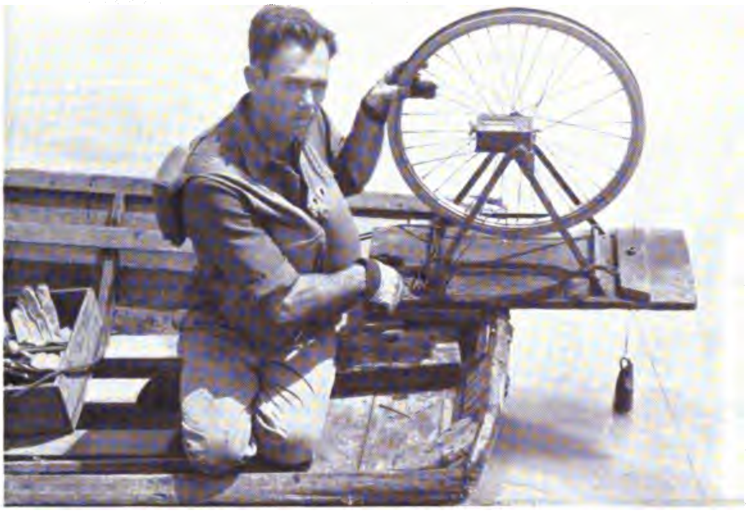


FIGURE 8.

Another specialized design is Sutcliff's sounding gear (figure 10), used in England but not so well known in this country.

The sounding line (wire) is carried in a spiral track or slot on the periphery of a wheel of about 10-foot circumference. This wheel is mounted aft and on one side of the survey boat. A lead of about 40 pounds is attached to the sounding line, and after the depth-scale index has been set to zero for the water-surface position all depths can be read directly from the circular scale at 10 feet per revolution. The novel feature of the gear consists of the check line, which

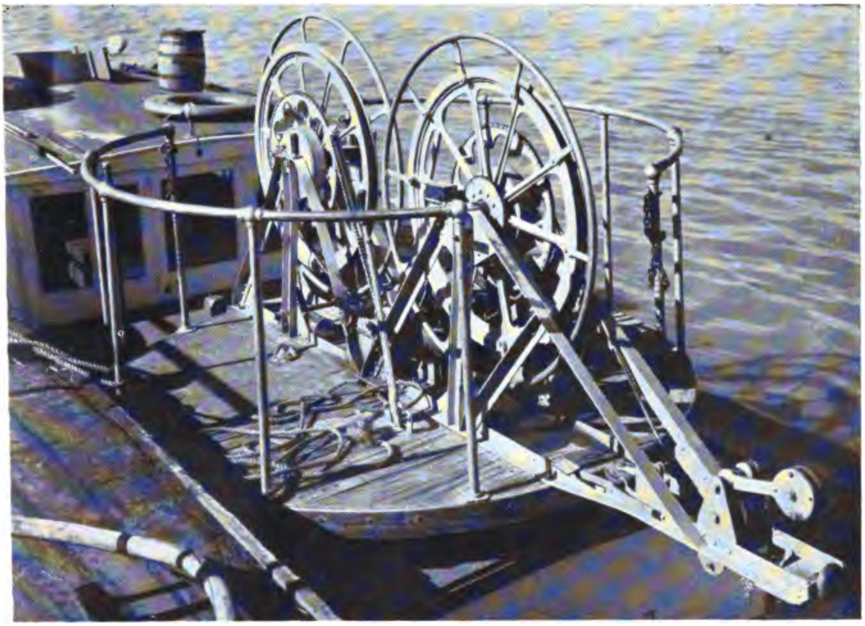


Figure 9.

is attached to the lead and thence through a grooved sheave at the end of a boom projecting across and beyond the bow. From the sheave the check line is brought back to a reel with a spiral track mounted on the same shaft with the depth wheel. The reel is so designed in relation to the depth wheel that with all changes in depth

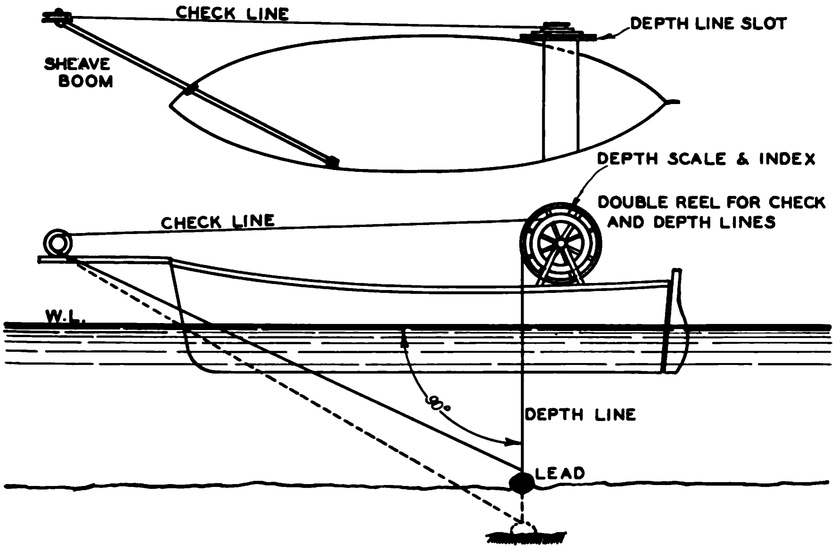


Figure 10.

the 90° angle will be maintained as shown in the sketch. In other words, in theory the sounding line will always be perpendicular. When operating the rig in shoal waters, as the boat moves over the area the lead is just raised a turn or so off the bottom between soundings and dropped as required.

The British Admiralty employs a method much similar to this but termed the Somerville sounding system.

It seems obvious that the efficacy of the check-line idea is quite dependent upon its use in shoal water at relatively low boat speeds, as otherwise, in spite of all theoretical considerations, the catenary error in the sounding line becomes appreciable. In any case swift currents should be avoided. Another novel sounding method, and one that attained considerable vogue in its day, was the submarine sentry, or kite, of Mr. Samuel H. James. The device consisted of a sounding line wound on an indicating wheel, with a lead of unusual design. The lead included a trigger attachment to which was fastened a wooden device like an inverted kite. As the vessel moved forward the lead was towed along, and with the added resistance of the kite maintained considerable tension in the line tending to minimize the catenary effect. The lead gradually sank, and upon touching bottom the trigger released the kite, which rose to the surface to be reclaimed later or left to its own devices. Upon release of the kite, tension on the line relaxed, and readings were taken immediately of the length of line out and the angle that the line made with the perpendicular. At the instant of kite release, and assuming the line to have no sag or catenary, then from figure 11 it is obvious that depth D is equal to L cos ϕ less the constant d, and

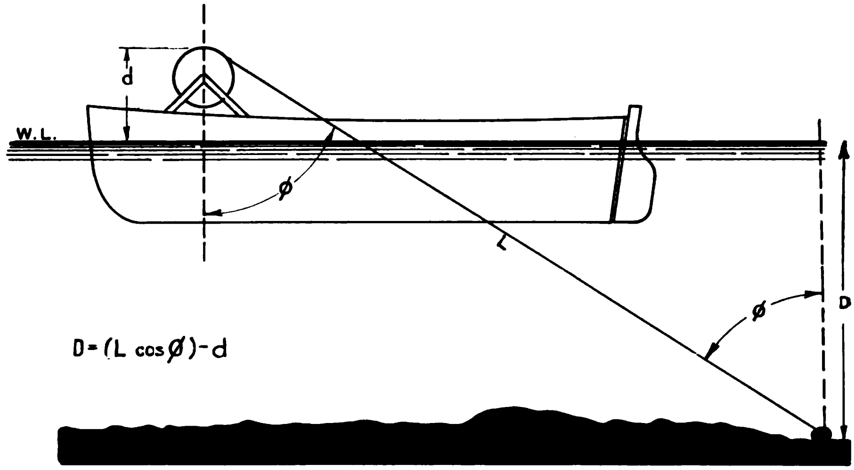


Figure 11.

thus the depth may be readily calculated. Claims for the device as a shoal-water alarm would appear to be of doubtful validity, as a trailing sentry alarm is often too late to be of value.

A sounding machine consists of a reel, drum, or wheel mounted upon a pedestal or stand so that it will be free to turn, operated by hand or power and generally fitted with suitable clutching and braking devices. Such machines use stranded or piano wire on the reel, a lead or other weight attached to the end of the wire together with a bottom sampler, thermometer or other accessory apparatus, and a registering sheave to indicate the length of wire run off the reel. To take a machine sounding the vessel is stopped, the sounding wire is run out until the lead touches bottom, the depth is read from the indicator, and then the wire is rewound upon the reel. Bottom samples, temperature readings, etc., are obtained when the lead comes up.

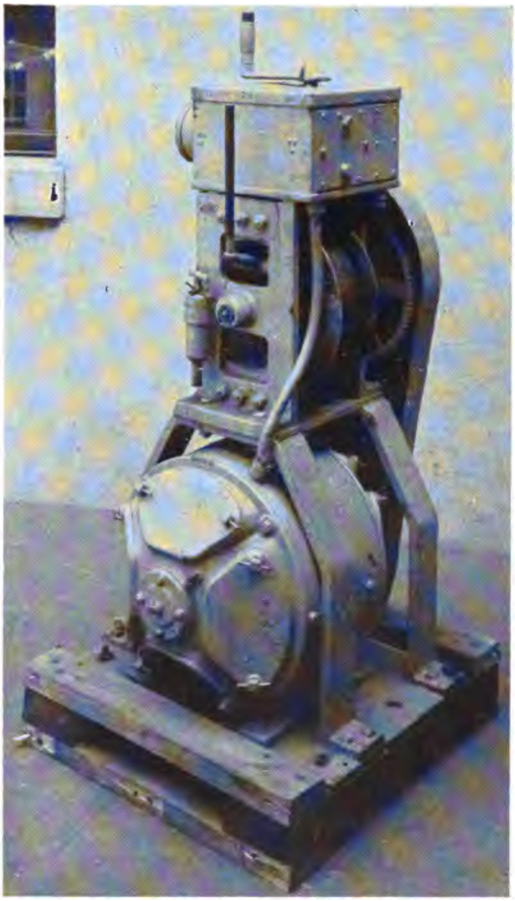


FIGURE 12.

Perhaps the earliest sounding machine to gain any wide acceptance was the Sigsbee deep-sea sounding machine developed about 1880. There are many other sounding machines of various names and with various features for special applications, but in general they are all closely related to the Sigsbee model.

Figures 12, 13, and 14 show three models used by the United States Coast and Geodetic Survey for the precise type of work that they do. Figure 15 shows in greater detail the registering sheave for the larger machines.

In the British service the models are much similar, but they bear other names to designate them. One of these is the Lucas sounding machine shown in figure 16.

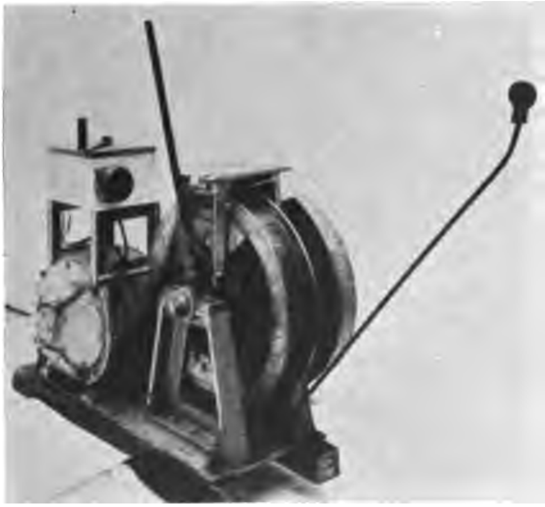


FIGURE 13.

The hand- and power-operated sounding wheels previously noted as in common use for shoal-water survey use in the United States Engineer Department are but other adaptations of the sounding-machine idea.

The Sigsbee sounding machine and other adaptations of more recent origin are still in limited use in the United States Navy.

III. *Wire drags and sweeps.*—Surveys by spot methods such as the pole, lead line, or sounding machine, will generally suffice except in regions of rocky and irregular bottom. In such cases, to insure that there are no obstructions of small area such as pinnacles, ledges, and boulders, a wire drag or sweep is frequently resorted to. The wire drag consists essentially of a wire or cable held in a horizontal position at the desired depth by a series of weights and supported by buoys or floats from which it is suspended. The wire drag as we

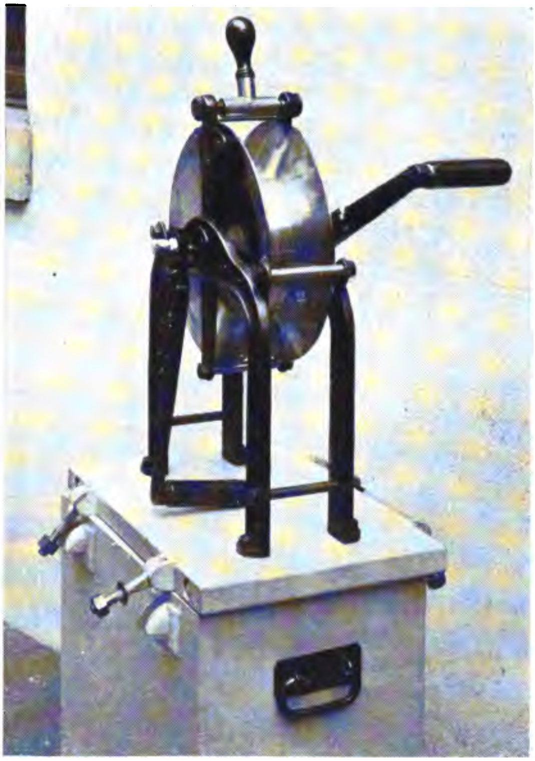


FIGURE 14.

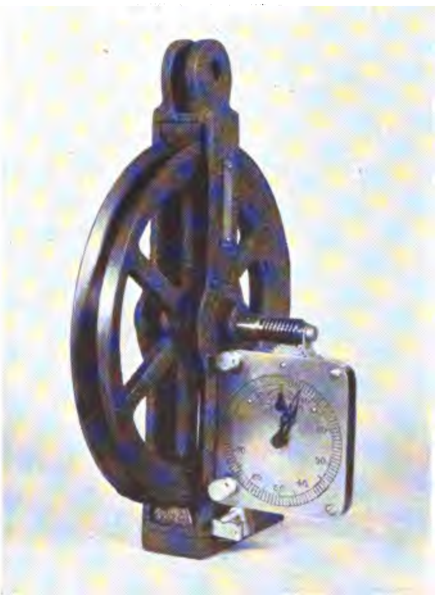


FIGURE 15.

know it today was first devised and used in survey operations by F. C. Shenahon, of the Lake Survey District of the United States Engineer Department, in 1902. Since that time the method has proved its worth many times under various circumstances, until it is now in use the world over. The method as originally conceived was so fundamentally sound that few changes have been made through the years, and those changes have been of a minor nature. An adaptation of this type of drag has also seen considerable use in mine sweeping. In the more elaborate models the suspending wires are wound upon reels mounted upon the floats so that the depth of the drag may be readily adjusted. The horizontal wire is towed by a vessel at each end, and the wire will catch on any obstruction in its path which projects above the set depth. Figure 17 shows such a wire drag in operation, and in this particular instance a flag has been attached to each suspending wire so that a tipped flag will more accurately locate the obstruction laterally.

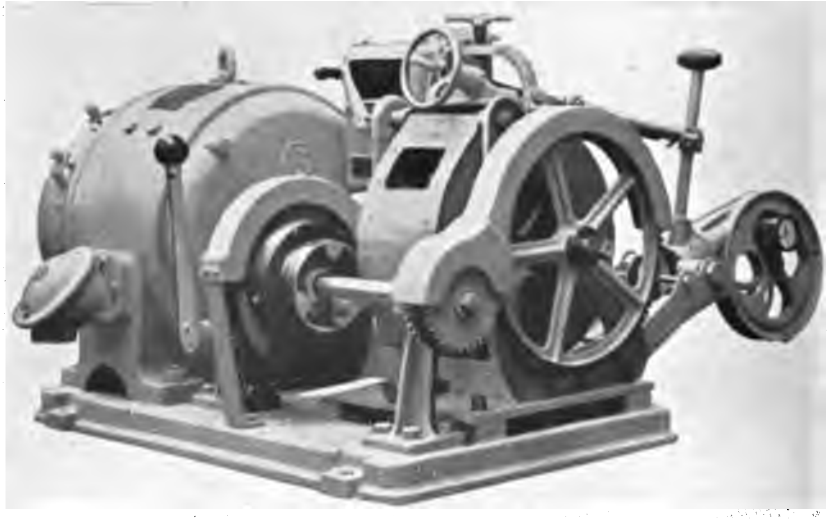


FIGURE 16.

The wire sweep is merely another form of drag adapted for use where the general depth considerably exceeds the check depth and where few if any obstructions are expected. The wire sweep is often buoyed at long intervals, and provision is seldom made for preventing the wire from sagging between buoys.

For channel work in the relatively shoal water of harbors a bar type of sweep is commonly used to locate obstructions. This gear generally consists of a heavy steel bar or section suspended below a vessel, barge, or a line of barges and dragged over the area under investigation. The suspension lines are wound on drums so that the depth of the sweep bar can be changed at will according to tidal variations. Figure 18 shows a bar-sweep party operating a sweep from a series of barges in New York Harbor, with a tugboat in attendance for maneuvering the barges as required, although the survey work is generally done with the barges drifting.

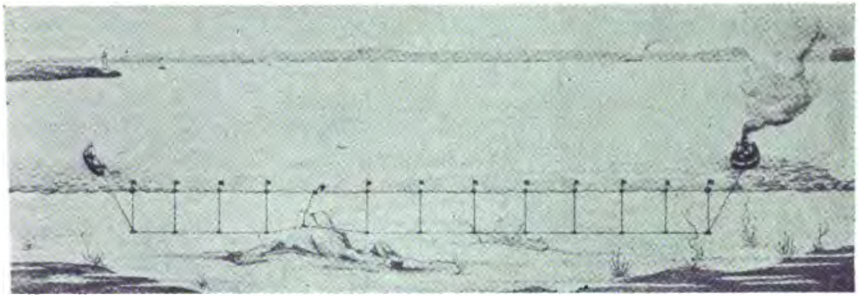


FIGURE 17.

IV. *Errors in depth measurement by lead line.*—There are a number of well-recognized errors inherent in lead-line soundings, and most of them are in the positive, or overdepth, direction. If errors are to be tolerated, they should not be in that direction, as therein lies the danger of running aground. Some of the common errors are:

(*a*) The uncertainty of just when the lead comes in contact with the bottom. In shoal water with a hard bottom this error, if present at all, is of small magnitude. In deeper water, and particularly where the bottom is soft, contact may be quite indefinite and the errors may be appreciable. Frequently a disk has been attached to the lead to prevent it from sinking into mud and silt on the

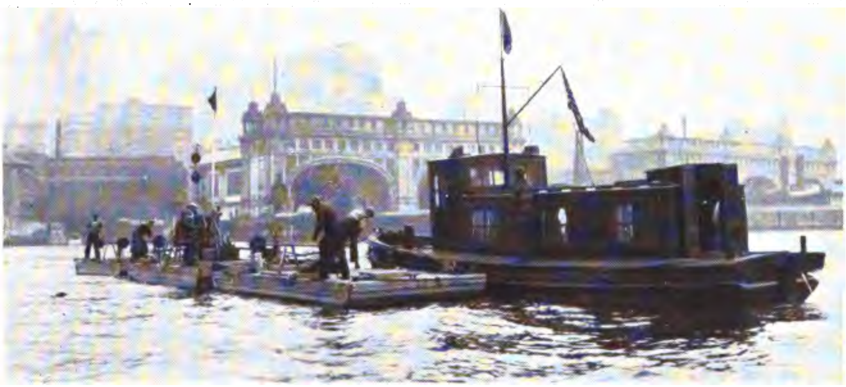


FIGURE 18.

bottom, but this is generally recognized as a makeshift rather than a positive cure.

(*b*) Shrinkage in the sounding line. The advent of the wire-core line and the widely adopted practice of alternate soaking and stretching of the line have done much to minimize this error, but they have not eliminated it. Periodic checks and calibrations are helpful, and there are those who advocate waterproofing treatments, but the error persistently refuses to be downed.

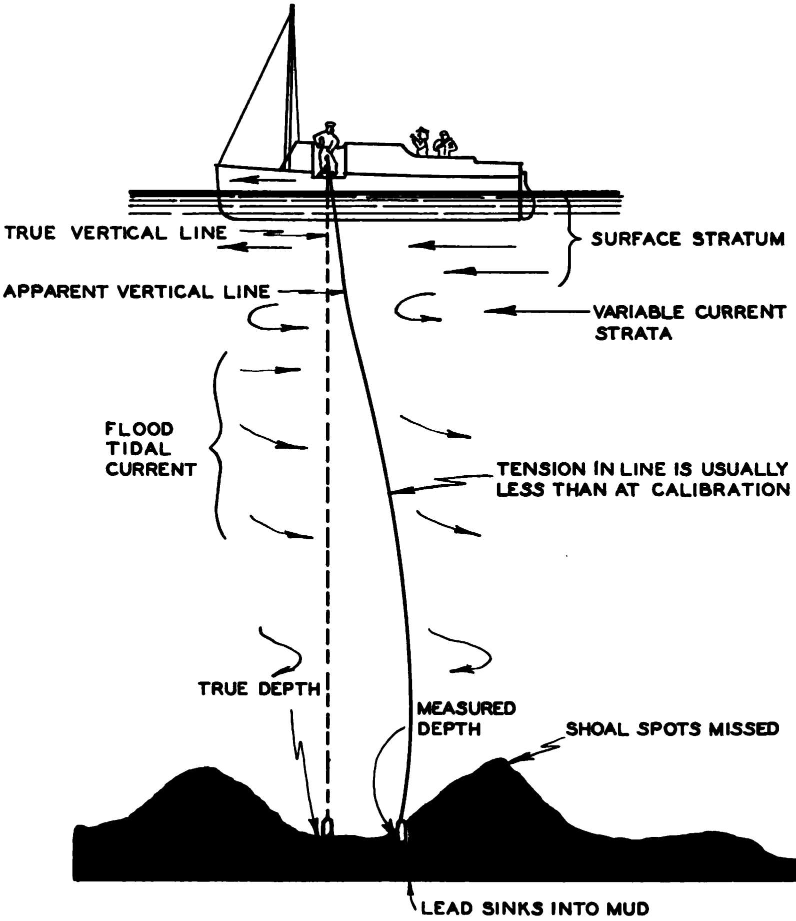


FIGURE 19.

(*c*) Catenary in the sounding line. This is one of the most intangible of lead-line errors and at the same time it is frequently of considerable magnitude. The magnitude is a function of the water motion whether the motion be on the surface or in substrata. In precise work attempts have been made to calculate the catenary and apply a mathematical correction, but like the weather this variable does not submit readily to control.

(*d*) Sounding line not vertical. In order to cover a given area in a reasonable time lead-line soundings are often made with the survey boat under way. Under such conditions true vertical casts can only be assured by the most experienced leadsman and then perhaps with some reservations. It is obvious that the very small instant afforded for the leadsman to plumb and feel bottom while the line is vertical hardly contributes to precise work. Here the human equation is a large factor, and the survey party has never as yet included a psychologist.

The knowledge that these errors are present in practically every sounding prompts the leadsman to apply his own correction to each cast, so that he tends to read the line somewhat on the shoal side. The correction must be applied quickly, so that it amounts to an estimate. Then if the recorder in the party has his own theory of correction the net result might be truly astonishing.

Figure 19 shows some of the more common lead-line sounding errors in graphic form.

SEMI-DIRECT-SOUNDING METHODS

The sounding methods which have been discussed are generally classified as direct because direct physical contact must be made with the bottom at the time of actually making the depth measurement. It can be readily seen that this limitation alone is responsible for many of the errors inherent in the direct methods. Thus if this restriction can be removed without breeding a host of other objections, real progress has been made.

All the methods developed to date which may be classified as semi-direct operate upon the pressure principle.

I. *Thomson wire sounding machine.*—Of the semi-direct methods, probably the best known is the Kelvin or Thomson wire sounding machine, to which reference has been previously made. This device, originally made in 1881, has been improved in several respects, notably by Capt. G. T. Rude, of the United States Coast and Geodetic Survey, in 1911. Figure 20 and the description of the tube are abstracted from the Hydrographic Manual of the United States Coast and Geodetic Survey.

The tube consists of a 2-foot section of standard brass tubing, one-half inch inside diameter, with one end permanently closed. It is fitted with two straps with eyes for attachment to the sounding wire. When used for sounding, the open end of the tube is covered by a brass cap in which a small winding hole forms a capillary tube about 3 inches long. This opening will admit water to the tube under pressure without allowing the air to escape.

When the tube is lowered to the bottom, a certain amount of water, depending upon the pressure due to the depth, is forced into it. When it is brought to the surface the water is trapped in the bottom

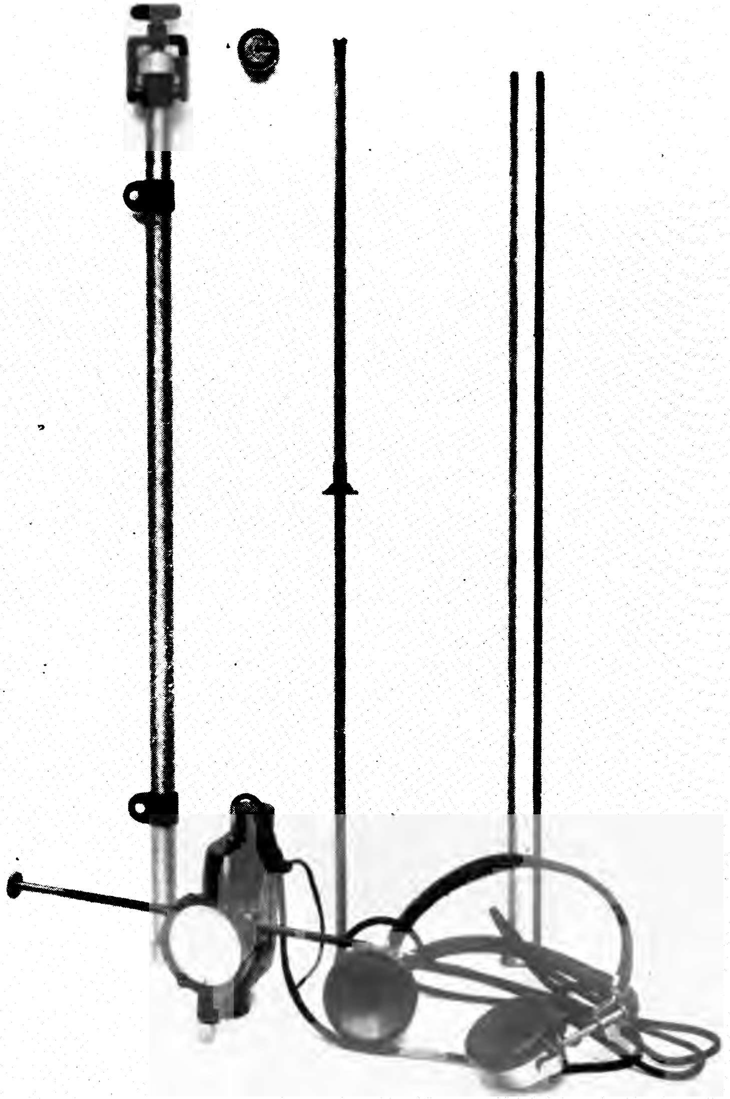


Figure 20.

of the tube and the air escapes through the cap. The amount of water in the tube is measured by removing the cap and inserting a brass rod of certain cross section until the water is about to overflow. The distance that the rod is inserted is indicated by a sliding marker that rests against the end of the tube. The depth is read by holding the rod against a scale so graduated that, when the end of the rod rests against a stop, the depth in fathoms is indicated by the position of the sliding marker.

The insertion of the measuring rod exactly to the overflow point is a delicate operation, especially if the sea is at all rough. To obviate this difficulty an electric measuring instrument has been devised. This also is illustrated in figure 20. It incloses two flashlight batteries and has a headphone connection. It is clamped to the open end of the tube, and the movable rod is lowered until its point strikes the water in the tube, when an electrical circuit is established which causes a click in the phones. The moving rod actuates a pointer which indicates the proper depth on a dial. For tube sounding, stranded wire and a 30- or 40-pound lead are used with a hand or power sounding machine, the latter of course being preferable and always used if available. As the vessel moves slowly on her course, the machine is released, the wire runs out at an angle over a fair-lead until the lead reaches bottom, and the wire is then reeled in. The general practice is to use two pairs of tubes, lowering one pair while the others are being read and prepared for the next sounding. No record is required of the amount of wire run out.

II. *Ericcson sounder.*—In 1837 Ericcson developed a pressure method of sounding which has been previously described and which failed to gain any wide acceptance chiefly because the pressure tube had to be lowered and raised vertically to operate properly.

III. *Hunt-suggested sounder.*—In 1858 Lt. E. B. Hunt suggested the use of an equipment involving the use of a flexible rubber bag with a hose attached and a sinker to carry the bag to the bottom. The hose was to reach from the mouth of the bag to a closed mercury well on the survey vessel. Then a mercury column in a glass tube was to indicate the pressure from the bag which was exerted upon the mercury in the well and thus be an index of the water depth. Realizing the compressibility of the air in the closed system he further suggested that the system be filled with sulphuric ether, olive oil, alcohol, whale oil, linseed oil, turpentine, or wine instead of air. He also suggested a method of recording the depths as the rubber bag was dragged over the bottom. There is no evidence to indicate that the suggestions ever resulted in the actual production of such an apparatus.

IV. *Wheeler bathometer.*—In 1908 a sounding machine, called the bathometer and patented by Mr. E. S. Wheeler, was purchased by the United States engineer office at Detroit, Mich. This device recorded depths of water by measuring an equivalent air pressure in a flexible tube which extended from the observer's station to the bottom of the waterway. A slight excess of air was continuously pumped into the tube and slowly escaped from the submerged end, requiring various adjustments to the apparatus to insure correct readings. After extensive trials the results obtained were not considered accurate enough and its use was discontinued.

V. *Recording pressure sounder.*—About 1928 an instrument termed a graphic pressure sounder was developed and introduced into survey use in the United States engineer district at New York. The apparatus consists essentially of three units—a sounding pressure bell, a pressure recorder, and an air pump. Figure 21 shows the component parts of the pressure bell, and figure 22 shows the bell assembled with the pressure hose attached.

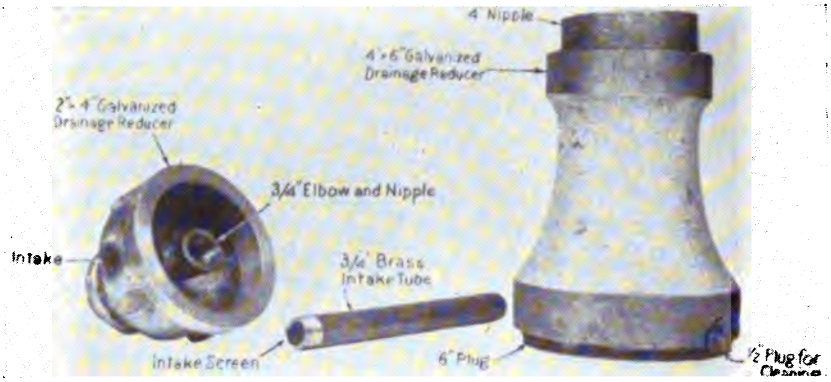


FIGURE 21.

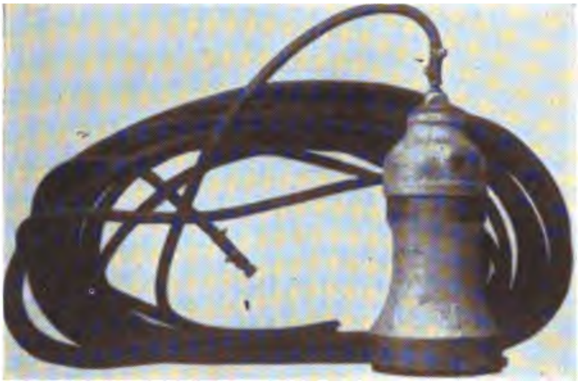


FIGURE 22.

During operation it was customary to connect the pressure bell to the recorder with about 100 feet of 1/4-inch flexible tubing or hose. The pressure bell weighed 29 pounds. In actual sounding operations the leadsman, using the air hose as a line, lowers the bell until it touches bottom. Then he immediately raises it 3 to 5 feet and lowers it when the next sounding is to be made. This procedure is continued until the survey range has been sounded, when the bell is raised and the survey vessel moves to the next range. The recorder on the boat automatically records the depth (pressure) reached by the sounder at each cast along the range, and the intervals on the record between casts are a rough measure of the distance traversed from point to point. The observer at the recorder renews the air column as required, changes instrument charts, and advises the party chief of any unusual bottom conditions noted.

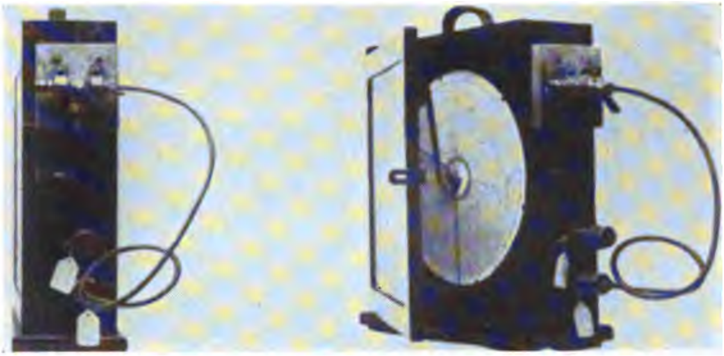


FIGURE 23.

The recording instrument used was a regular commercial-type low-range circular-chart pressure recorder mounted in a special portable case with pressure connections on the side of the case. In order to insure having an open scale for shoal depths where the need for it is greatest, the recorder was designed with two pens and two ranges 0 to 25 feet and 0 to 50 feet. The recorder unit is shown in figure 23, and figure 24 shows the complete equipment, including the hose and hand pump.

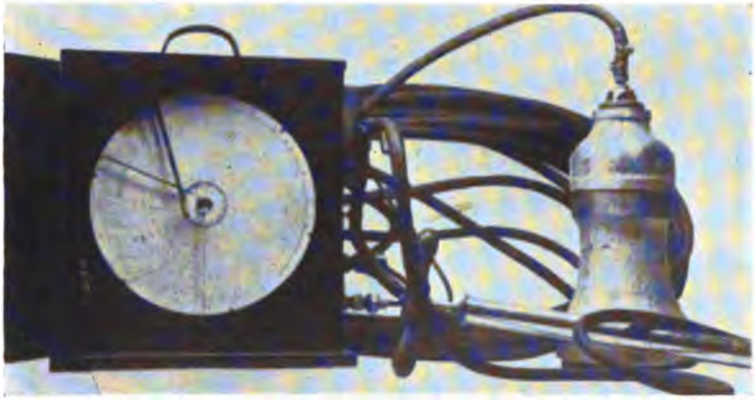


FIGURE 24.

It was found advisable to force all water from the sounding bell periodically to get the best results. This was done by simply applying more air pressure to the bell from time to time with the pump until excess air was indicated by rising bubbles. This method has much to recommend it, and it was in continuous service in the vicinity of New York for a number of years until replaced by echo sounding devices.

VI. *Hughes Discovery pressure sounder.*—Another pressure-responsive device is the Discovery depth gage developed by Henry Hughes & Son, of London, and still on the market.

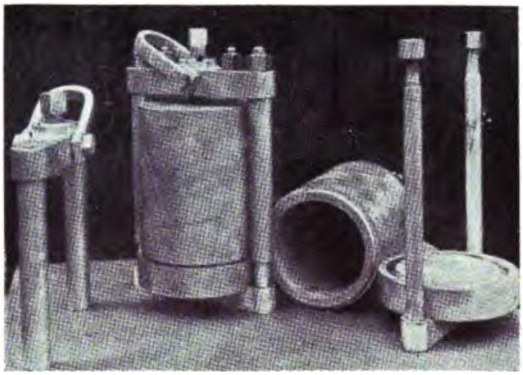


FIGURE 24–A.

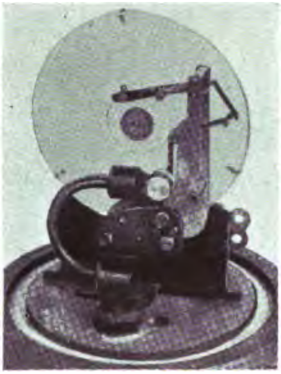


FIGURE 24–B.

Figure 24–A shows this gage assembled and with the various parts of the casing removed. The essential operating parts are shown in figure 24–B. The response element is a heavy Bourdon tube with an associated lever system to mechanically amplify the tube motion as the pressure varies. The lever system operates a pen which records the depth record on a circular, revolving, clock-driven chart. It is probable that this device is subject to the usual Bourdon-tube errors due to inertia and hysteresis.

OBJECTIONS TO PRESSURE METHODS

While pressure methods do overcome many of the objections which are the bane of the surveyor with lead and line, they still fall far short of the requirements of a precise and efficient hydrographic survey job.

One of the major requirements is speed in surveying, and the mere fact that the pressure-responsive element, be it a tube or a bell, must be lowered to the bottom and raised, even though it be but a few feet, does little to promote survey speed.

Another element which militates against pressure methods is the lack of sensitivity inherent in the system. A foot of water with small area does not exert enough pressure to cause a large response in the overboard element, and the alternatives of bulkier elements or more sensitive meters are not attractive. For shoal depths where rapid work is in greatest demand these objections loom the largest.

INDIRECT-SOUNDING METHODS

The following methods are classified as indirect because they involve no direct physical contact with the bottom at the time when the measurement is made. In general they adapt themselves well to speed of operation. While they do not involve the errors common to the more direct methods, they have bred a considerable family of their own which cannot be ignored. Many of the more technical phases of sonic and supersonic depth measurement will be mentioned but not discussed in detail, as present textbook treatment of the theoretical considerations seems adequate.

I. SIEMENS GRAVITY METHOD

Between 1859 and 1876 C. W. Siemens conducted a series of experiments with a gravity-actuated device which was quite novel and original in its conception and design. A column of mercury was continuously balanced against a spiral spring which was sensitive to variations in the force of gravity. At sea this force varies with changes in depth, being less as depth increases. Unfortunately, there was more to the problem than that, for the spring was also sensitive to changes in temperature, pressure, and latitude, so that the matter of compensation became rather complex. In addition, the question of sensitivity was a major one, for great sensitivity was required, and in order to obtain it the instrument became too delicate for shipboard use. Thus this idea died "a-borning."

II. SONIC-ECHO METHOD

It is probably natural enough that the early echo sounding work of Dr. Behm in Germany and Professor Fessenden in the United States was all done with sonic or audible frequencies, for we are all more familiar with the sounds that we can hear.

Sound waves move forward by a series of compressions and rarefactions of the medium in which they exist. The velocity of these waves in any medium is determined by the density and compressibility of the medium, but it is not a function of the wave frequency. In other words, in a given medium an audible sound travels at the same velocity as one above or below the audible range. Water is an electrical conductor, but as there is no electrical field produced, as with radio or electromagnetic waves, there is no rapid absorption of sound waves in water. There is some absorption of energy due to the alternate compression and rarefaction of the medium. This attenuation or loss of energy is due principally to two factors: The first is the viscosity of the medium and the second the heat conductivity of the medium. Viscosity changes some of the wave energy into heat by shearing and internal friction, and heat conductivity dissipates the energy in the form of heat. As water is so slightly compressible, the attenuation due to heat conductivity is seldom appreciable, so that practically all absorption is due to viscosity alone. Absorption is the factor which restricts the distance that a sound wave will travel, and this distance varies with the square of the wavelength. Thus the waves of lower frequency (greater wavelength) are absorbed less and travel farther than those of higher frequency.

It is therefore true that insofar as distance of transmission and penetration are concerned the advantage lies with low frequencies over high frequencies. However, the question of low versus high frequencies is seldom decided as simply as that, for there are generally other important factors to be considered. In the shoal waters of rivers and harbors these other factors assume larger proportions, and matters of distance and penetration need not be weighted so heavily.

Without listing at this time the objectionable features of sonic frequencies for echo sounding it will perhaps suffice to note the fact that sonic systems are now accepted as well adapted to sounding at the greater depths, as at sea. For such applications the advantageous factors are of paramount importance. Several systems which have seen some use in the sonic echo sounding field are listed, together with the outstanding features of each.

1. *The Fessenden system.*—The oscillator developed by Professor Fessenden and the depth-indicating device used with it have been described. The oscillator has seen extensive service in the field of submarine signaling, and in modified form it has been adapted to some types of echo sounding. The indicator originally used with this oscillator never saw commercial service. For regular commercial use the associates of Professor Fessenden at Submarine Signal Co. devel-

oped a sonic oscillator of the plunger or impact type which, with minor modifications, is in active service today.

The essential parts of this oscillator are shown in figure 25. A motor-driven cam closes a switch which energizes the electromagnet, raising the plunger against the steel spring. At a later point on its travel the cam opens the electromagnet circuit and the spring drives the plunger against the diaphragm with the same force at each blow, so that each sound wave emitted has equal energy. The cycle of raising and dropping the plunger continues for each blow struck and the timing of blows is controlled by a governed driving motor. The oscillator is mounted with the diaphragm flush with the outer hull surface of the vessel, or in some cases the unit is suspended in a water-filled tank in the hold. The tank is securely fastened to the inner hull surface and the sound is projected through the hull.

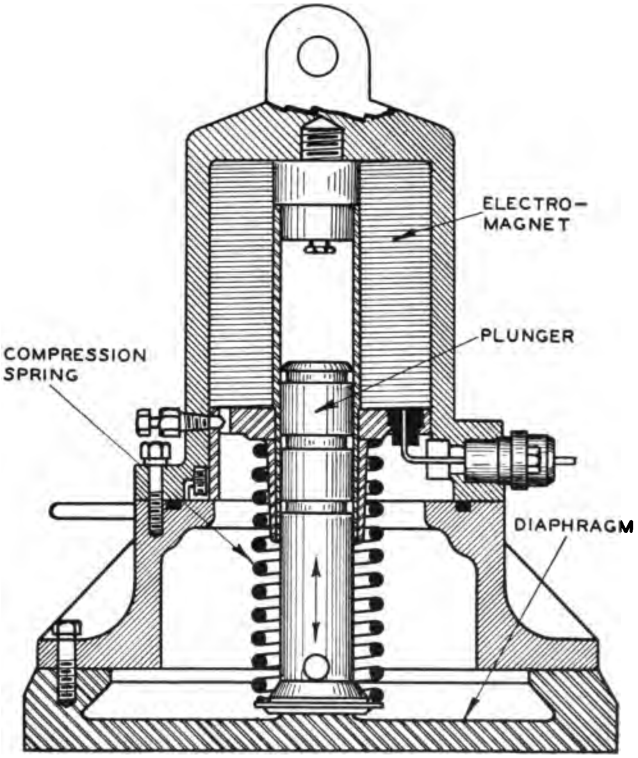


FIGURE 25.

The receiving element is a microphone, contained in a watertight case and mounted in a tank bolted to the hull plates of the vessel. This tank is also filled with water to provide a sound-conducting medium from the sea through the hull plates to the receiver. The hydrophone receiver transforms the sound energy into electrical energy, which is amplified in a conventional electronic amplifier and conducted to the indicating unit.

The indicator, figure 26, contains a thin metal disk rotated at constant speed by a governed motor. This disk has a single narrow radial slot cut in it near the outer edge, and behind the slot a small neon-filled tube is mounted on the disk. Thus from in front of the disk the glow from the neon-filled tube appears as a narrow, brilliant-red index line when the tube is momentarily flashed. In front of the rotating disk is the indicator window, opaque except for a transparent circular band the width of the radial slot in the disk and directly in front of this slot. On the opaque portion of the window and immediately outside or inside the transparent band is the scale calibrated in depth units (feet, fathoms, or meters). A small voltmeter, ammeter, line switch, and amplifier-gain control knob are also mounted on the front panel of the depth-indicator unit. When the plunger strikes the oscillator diaphragm a nondirectional sound wave is projected into the water. The wave travels toward the bottom, but a portion of it travels directly toward the hydrophone receiver and is picked up and amplified. This direct impulse will cause the indicating light to flash, and the flash will read zero on the depth scale, as this is zero time or the time of wave emission. When the sound wave strikes the

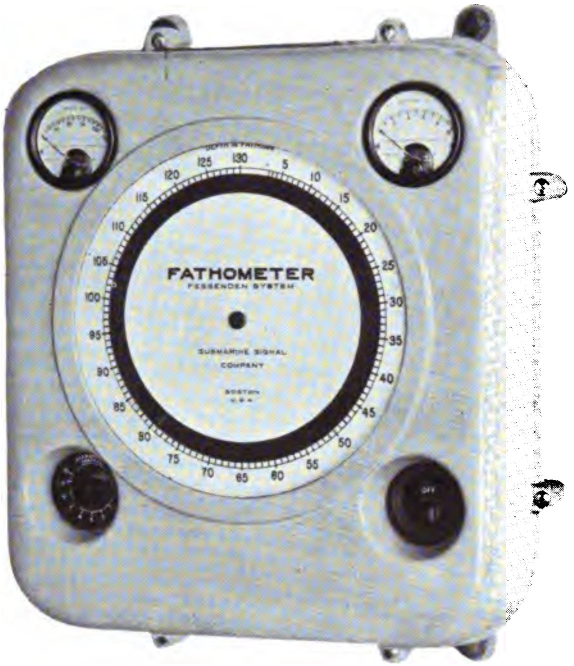


FIGURE 26.

sea bottom, due to the change of density (liquid to solid) it will be echoed or reflected back toward the water surface. When the reflected wave strikes the hydrophone it will cause the indicator neon light to flash again. However, during the time that the sound has traveled from the oscillator to the bottom and back the rotating disk in the indicator has turned. The angle through which the disk has turned will depend upon the time required for the sound to reach the bottom and return, and this time is a direct measure of the depth of water involved. Thus the indicating scale can be calibrated in units of depth, and the second, or echo, flash will give a true depth reading.

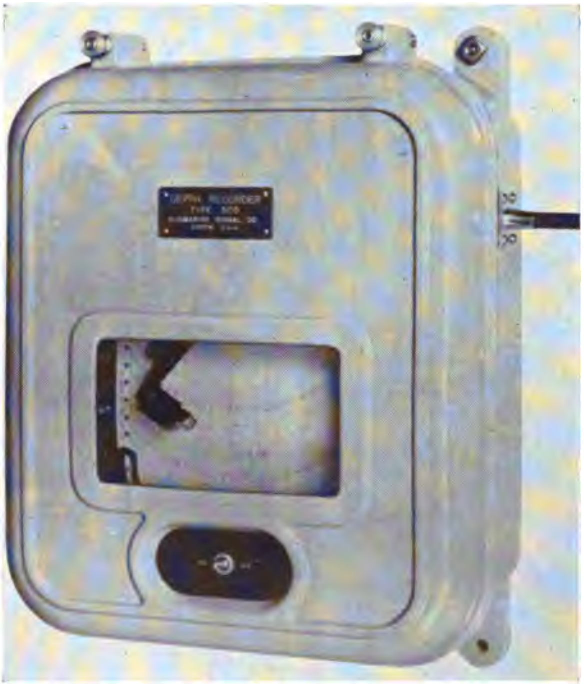


FIGURE 27.

Submarine Signal Co. also developed a recording apparatus for sonic depth measurement, and this instrument is in use both as an individual unit and in combination with their indicating units. As the sonic recorder is not intended for precise shoal depth sounding, it employs a pivoted arm with a relatively slow reciprocating motion. The arm carries a sharp stylus with a solenoid lifting device and records the depth upon an advancing processed and calibrated paper.

The recorder of this type, shown in figure 27, is mechanically coupled to and driven by an indicator through the shaft extension at the right.

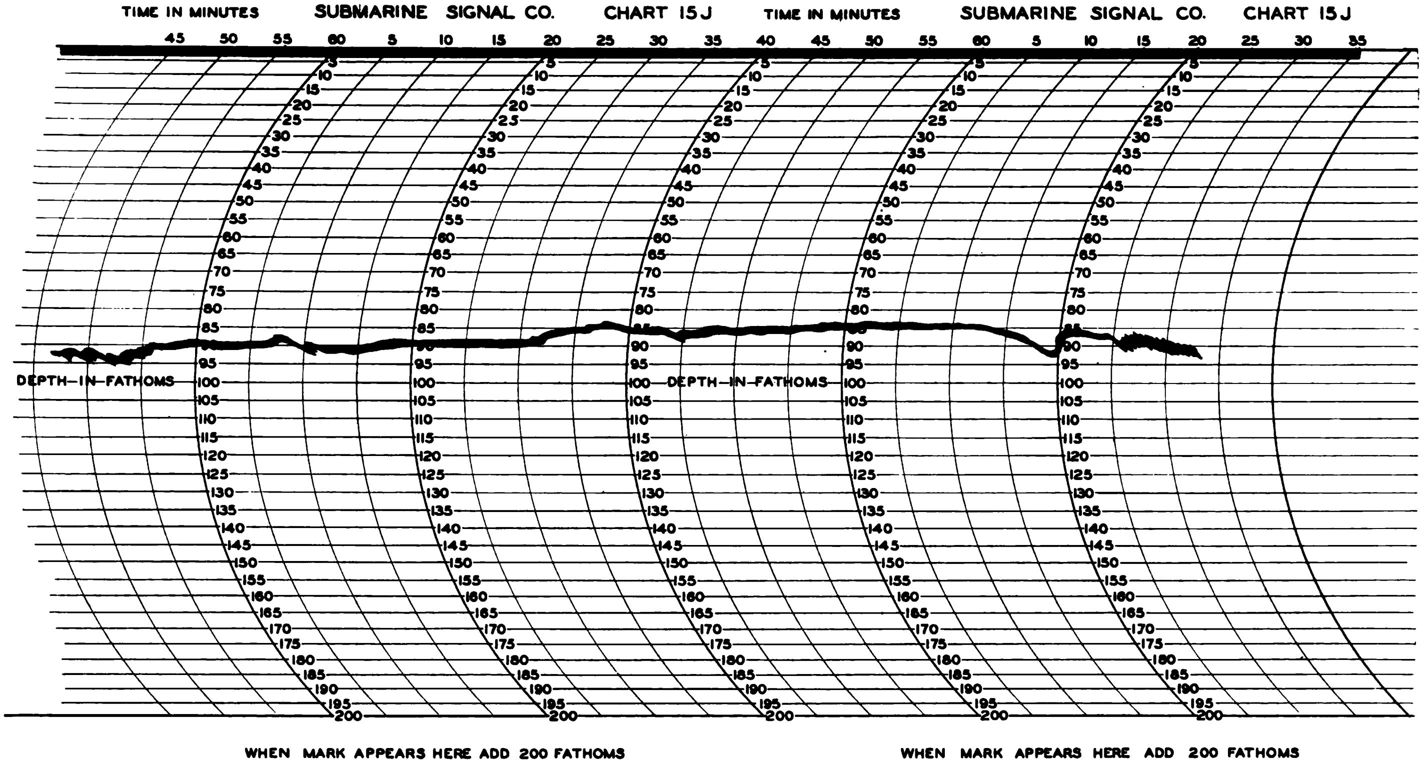

TIME IN MINUTES
SUBMARINE SIGNAL CO.
CHART 15 J
TIME IN MINUTES
SUBMARINE SIGNAL CO.
CHART 15 J
45
50
55
60
5
10
15
20
25
30
35
40
45
50
55
60
5
10
15
20
25
30
35
DEPTH—IN—FATHOMS
DEPTH—IN—FATHOMS
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200
WHEN MARK APPEARS HERE ADD 200 FATHOMS
WHEN MARK APPEARS HERE ADD 200 FATHOMS

FIGURE 28.

A portion of a sounding record made by one of these recorders is shown in figure 28. Recorded depths range from 83 to 90 fathoms, the true depth being read at the shoal side of the record trace. Note timing at the edge of the chart and the record band of direct sound reception at zero.

2. *The Behm Echolot system.*—It has been previously noted that Dr. Behm first experimented with the idea of measuring depth as a function of time interval, then abandoned this idea in favor of an intensity-of-echo method because of the difficulty of obtaining accurate timing. It appears that the alternative was not attractive, for Dr. Behm returned to the time-interval method, which, while far from perfect, has fewer objections than the substitutes thus far developed for general use.

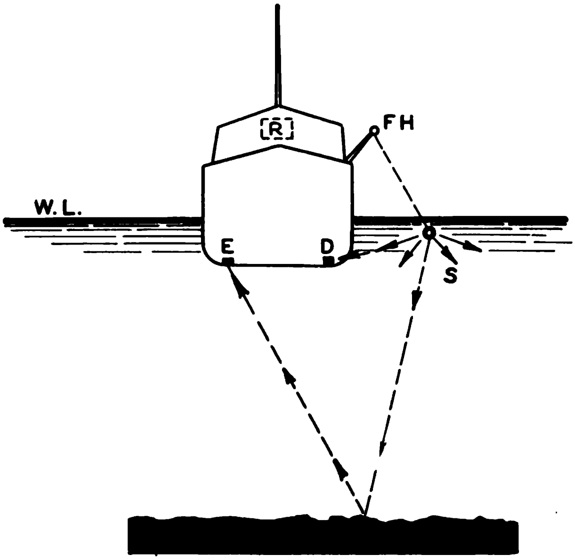


FIGURE 29.

The Behm Echolot system employs a cartridge or small bomb which is projected into the water, where it explodes just beneath the surface according to the setting of a time fuse. The time-interval measuring device is novel in that no motor, either clock-driven or electric, is used. In figure 29 *E* and *D* are hydrophones in the hull of the ship, *FH* is the firing head from which the cartridges are projected, *S* is the cartridge detonating under water, and *R* is the time-interval or depth-measuring device in the pilot house. When the charge detonates, the direct sound wave strikes hydrophone *D* and this impulse starts the time-interval instrument. The portion of the sound wave which goes to the bottom is reflected and of that a part strikes hydrophone *E*, which is shielded sufficiently from the direct wave so that it will not react to it. The echo impulse in hydrophone *E* then stops the apparatus, so that the time interval (a measure of depth) is indicated. In deeper water a time-delay relay is inserted in the circuit of hydrophone *E* so that its circuit is open until the direct wave has passed. This eliminates the possibility of stopping the indicator before the arrival of the echo.

The general construction of the Behm depth-indicating instrument is shown in figure 30.

Disk *A* is light in weight, very carefully balanced, and its edge is roughened or knurled for quick stopping. Armature *B* is attached to this disk. As shown, the apparatus is set ready to take a sounding. The rubber-faced brake shoe *F* is pulled away from the edge of disk *A* against spring *L* by the electromagnet *G*, and armature *B* is held against the face of electromagnet *H*. At the same time the jeweled projection *J* on the disk is in contact with the leaf spring *K* upon which tension is exerted. The face of magnet *H* determines the zero position of the disk and the amount of tension on spring *K*.

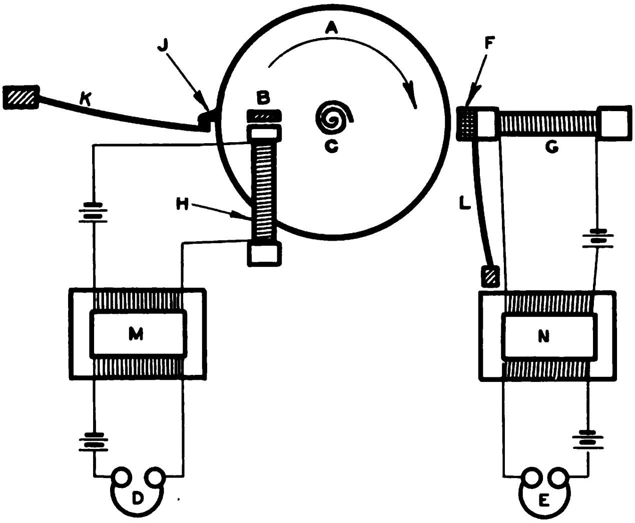


FIGURE 30.

When the direct sound wave arrives at hydrophone *D* (see fig. 29) an electrical impulse passes through transformer *M*, causing its magnetizing current to decrease to a point where magnet *H* releases armature *B*. Then spring *K* sets disk *A* in motion at a speed which will depend only upon the inertia of the disk and the force of the spring. As the echoed impulse strikes hydrophone *E* (see fig. 29) the pull of magnet *G* on brake *F* is reduced and the tension in spring *L* causes the brake shoe to snap against the rough edge of the disk and clamp it at the point it had reached when the echo arrived. Thus the angle traversed by disk *A* is a measure of the time consumed for the sound wave to travel to the bottom and back. This time interval in turn is a function of water depth. If depth of water to the surface is desired the zero or armature position may be shifted to compensate. The instrument is set mechanically in preparation for the next sounding to be taken. When the brake is released spring *C* will return the disk to the zero position, although it adds no appreciable load to the normal disk operation.

Various models have been developed to measure depths to some 4,000 fathoms. The deep-sea models include a projection device for showing the depth reading on a ground-glass scale.

While the manual reset takes time and keeps the instrument from being considered as really automatic, compactness and initial cost are in its favor.

The Behm Limnlot is a portable model utilizing the regular Behm indicator mounted on a folding tripod, two hydrophones for outboard use, and a small hammer mechanism for creating the sound wave. The whole equipment can be fitted into a small carrying case and is thus truly portable. This model operates on 12 volts direct current at 1.5 amperes.

3. *The Husun system.*—In Great Britain much of the development of echo sounding equipment has been carried on by Henry Hughes & Son in collaboration with the British Admiralty.

The apparatus outlined in figure 31 is an early model which in many respects is equivalent to the Fessenden equipment of the same era but in some important details is quite different. The oscillator is of the impact type operated by an electromagnetic hammer striking the diaphragm in a hull tank to respond to both direct and reflected sound waves.

A governed motor *M* drives two commutators through a suitable gear reduction. If sound waves are emitted from the impact oscillator at a rate of three per second, then the motor-driven commutators are geared to revolve at a rate of 180 revolutions per minute, as commutator *A* controls the oscillator timing. Commutator *A* is a metal disk insulated from the drive shaft and having an insulated segment which, coming under the brushes once each revolution, opens the magnet on the oscillator, allowing the compressed spring to drive the plunger against the diaphragm. Commutator *B* on the same shaft with *A* is in the telephone receiver circuit, so that the receiver is short-circuited except for a short time (about one three-hundredth of a second) when the insulated segment of the commutator is under the brush. Thus only during this short time can any sound be heard in the receiver. Even then nothing will be heard unless the direct wave or the echo from the bottom happens to strike the hydrophone at that instant. Indicating disk *S*, which is not attached to the driven shaft, controls the position of the brushes in contact with commutator *B*. This disk is rotated slowly until a position is found where the echo is heard in the telephone receiver. As the zero or initial position of disk *S* corresponds to the angular position of the oscillator brushes, then the angle through which this disk must be turned to hear the echo is a measure of the time interval between sound emission and echo reception. With a sound-emission rate of three per second, one complete revolution of the receiver brushes is the time equivalent of one-third second, or 360 angular degrees equals one-third second. If the sound velocity in water is 4,800 feet per second, and for a certain sounding the disk *S* indicates a displacement of 90°, then the time interval indicated is $\frac{1}{3}\times\frac{90}{360}=\frac{1}{12}$ second. This corresponds to a total sound travel of 400 feet, or a depth of 200 feet. To avoid the necessity for such calculations

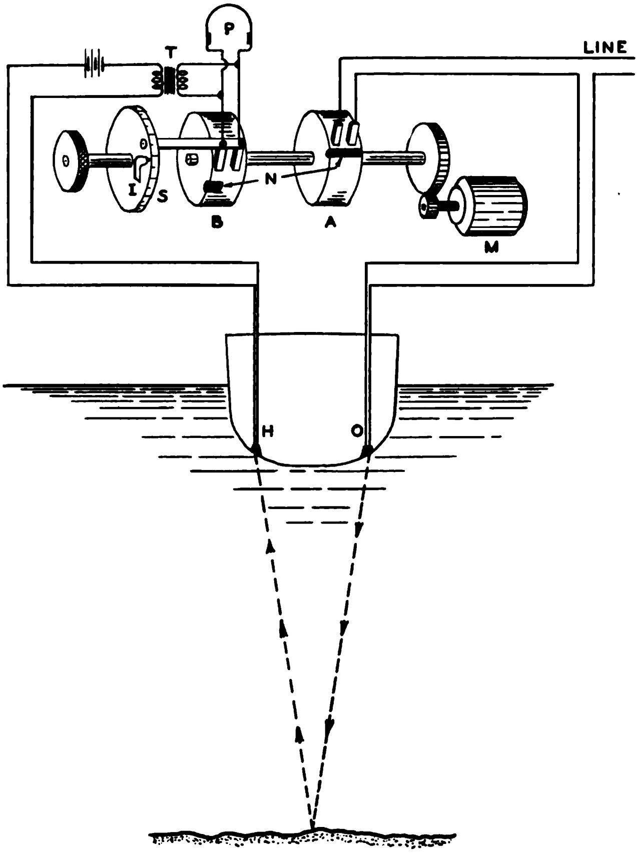


Figure 31.

the indicating dial S is calibrated directly in depths rather than in degrees of arc.

Later types of this machine for sounding in greater depths employ a pneumatic impact oscillator and a timing device of different design.

Henry Hughes & Son also developed recording devices for use in sonic-echo sounding. These recorders are quite ingenious in design and employ a reciprocating type of stylus carriage which marks the depth track on a chemically treated chart paper, which must be damp at the time the record is made. While the damp paper is of advantage from the point of view of sensitivity, shrinkage of the dry record presents some complications. The recorder shown in figure 32 is of the Hughes rectilinear chart type, and a section of such a depth chart is shown in figure 33.

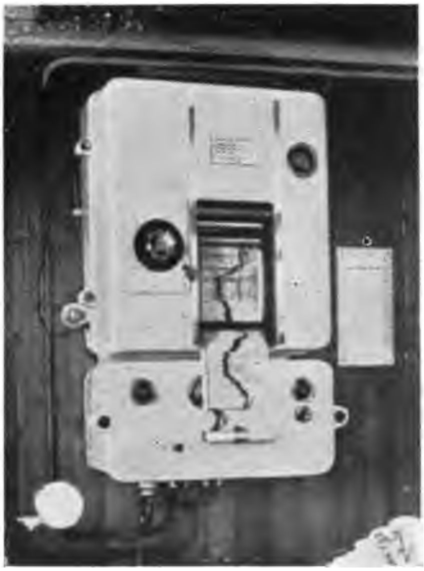


FIGURE 32.

4. *The Marti* (*S. I. E. R.*) *system.*—In France, M. Marti has developed a sonic system which has been manufactured and marketed by Societe Independente d'Exploitation Radio-Electrique (commonly abbreviated S. I. E. R.).

This company recommends various types of sound-wave generators depending upon the depth range in which soundings are desired. For depths of 10 to 200 meters an impact oscillator is used. For the depth range of 200 to 1,500 meters a form of bullet is fired into the water, and for greater depths a detonating cartridge is used.

Figure 34 is a diagram of one of the earlier Marti recording echo sounders. In this diagram separate sound transmitting and receiving units are shown such as would be used with the sonic devices previously noted. However, in practice the Marti recorder has also been extensively used with a single transceiver unit of the supersonic type which will be described later.

The motor *M* has attached to its shaft a centrifugal governor electrically connected in series with the motor through a resistor *E*, which is cut in or out of the circuit as the motor speed varies above or below control speed. Thus the motor speed is held constant within narrow limits. Attached to the same motor shaft is worm *W*, which drives the gear *H*. Rigidly attached to gear *H* is the double arm *B*, which carries oscillograph *O* and cam *D* at one end dynamically balanced by counterweight *P* at the other end. A smoked-paper record chart *F* moves under the stylus of oscillograph *O*, which draws arc lines on the chart until it is displaced by a received impulse. This displacement marks the depth on the chart. The oscillograph is connected to slip rings on gear *H* and thence through brushes to amplifier *A*, and from there to hydrophone *R*, where the echo from the bottom is received. A current will pass through the oscillograph due to both the direct wave and the reflected wave from the oscillator, and in both cases a deflection is recorded. The distance on the chart between these two deflections is in proportion to the elapsed time and is therefore a measure of the water depth. The sound emission is timed by the cam *D* closing contact *K* at the in-

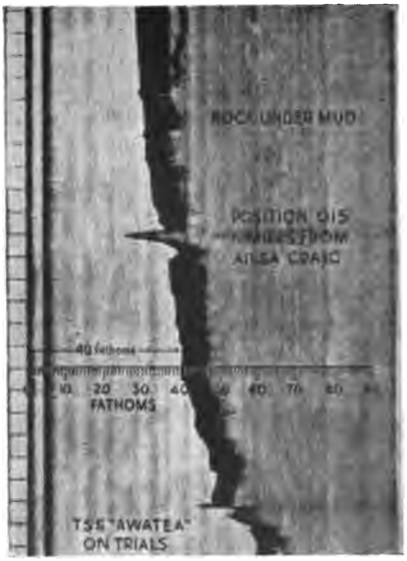


FIGURE 33.

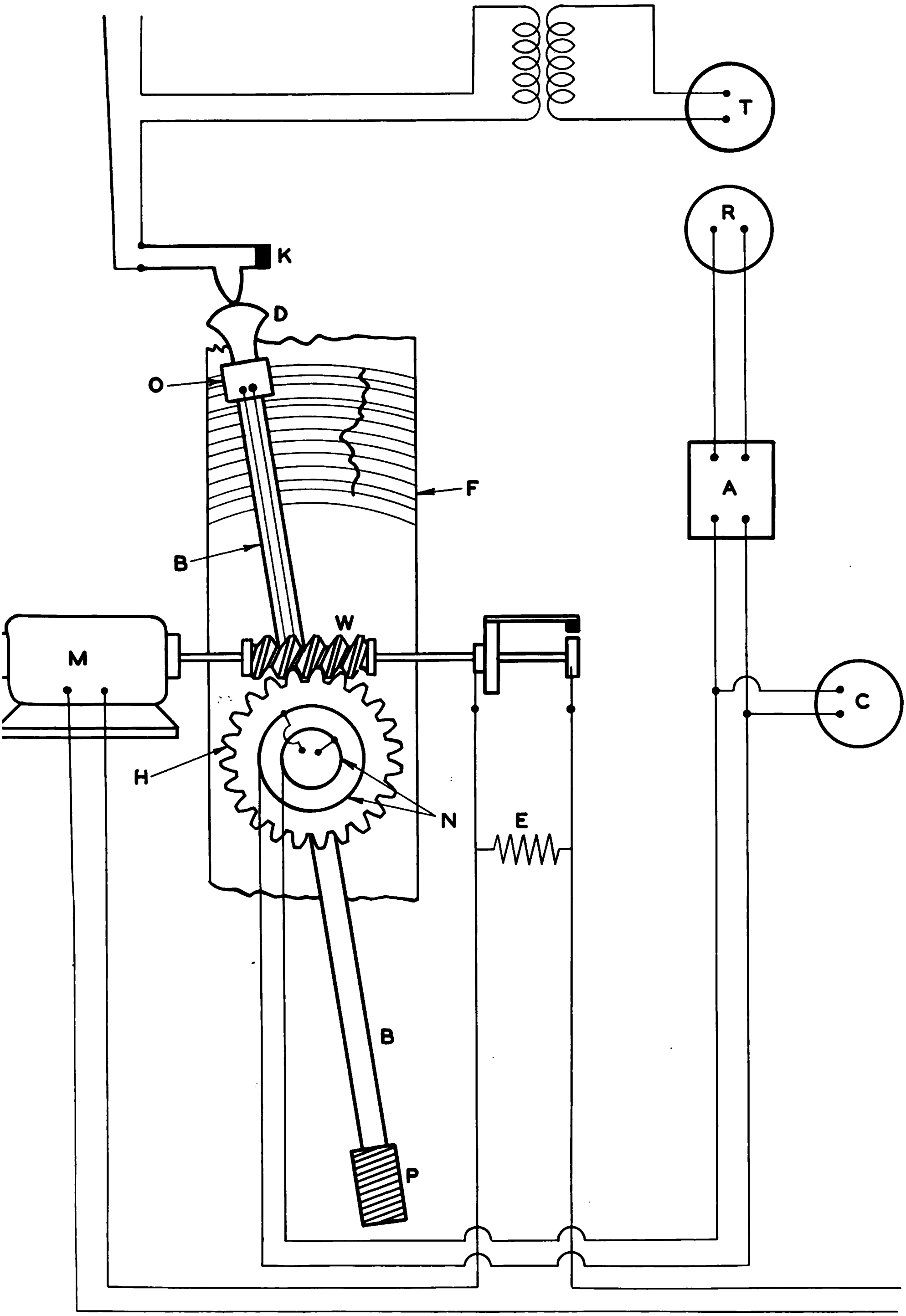


Figure 34.

stant when the stylus is at the zero division on the chart, so that the depth of water may be read directly from a calibrated chart. *C* is a contacting clock which periodically short-circuits the amplifier output, so that the depth record is missing for a short time. This makes it possible to determine the approximate position of soundings on a time basis by comparison with the ship's course and speed.

Later models of the Marti recorder include various design improvements, notably a chemically processed electrolytic recording paper.

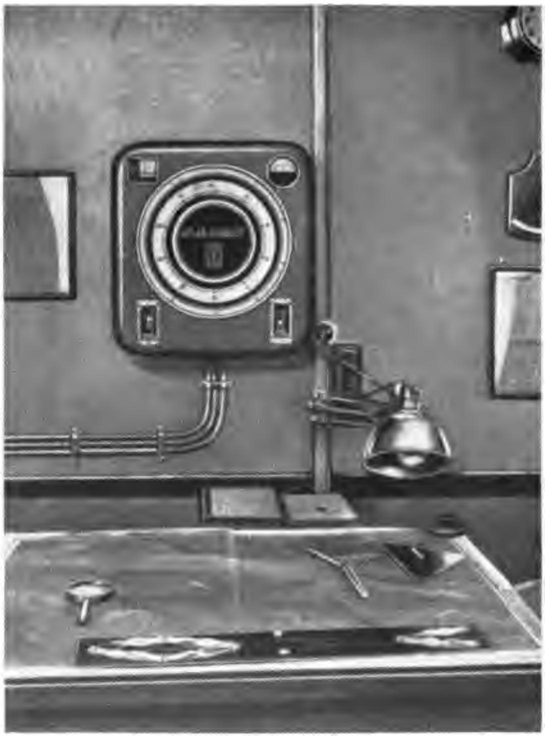


FIGURE 35.

5. *The Atlas Werke system.*—The Atlas Werke, of Bremen, has manufactured a series of indicating and recording echo sounders which in many respects resemble corresponding Submarine Signal Co. models in this country. The indicator, Atlas Echolot (fig. 35), includes the rotating disk with the flashing neon-tube index.

The recorder, Atlas Echograph (fig. 36), has a reciprocating stylus arm and a calibrated and wax-coated chart paper.

Atlas also manufactures a combination indicator and recorder unit in a single case, somewhat like the Submarine Signal Co. equivalent. This unit bears the name Atlas Registrierlot.

5–A. *The Atlas Freilot.*—An account of sonic devices would be incomplete without consideration of the Freilot, which is unique in that sound is used, but only for detection, not for measurement. The Freilot is essentially a small, light, and relatively inexpensive depth bomb which has been carefully designed exclusively for sounding. Figure 37 is a sectional view of this bomb. It is 6 inches long, weighs but 3½ ounces, and is capable of considerable accuracy. The Freilot was originally developed by Signal Gesselschaft, of Kiel, but of recent years it has become a product of Atlas Werke.

In order to take soundings with the device the vessel must be equipped with a hydrophone, mounted in the hull or suspended from an outboard mounting, and a set of telephone receivers. The manufacturer provides a stop watch which is calibrated in meters rather than in time units, so that depth will be indicated directly. A manual projecting device is also provided for convenience in casting the bomb and to insure removal of the firing pin so that the bomb will detonate upon striking the sea bottom. The act of casting the Freilot into the sea is shown in figure 38. Vanes at the top of the bomb maintain it in a vertical position and insure a constant rate of descent to the bottom.

FIGURE 36.

As the bomb starts its descent through the water its speed is first accelerated until the resistance of the water balances the initial acceleration. This balance is reached in a short time due to the low initial velocity, and from there on the speed of descent is constant at the rate for which the bomb was designed. The bomb shown in figure 37 has a velocity of 2 meters per second. If the stop watch be started at the instant the bomb enters the water and stopped

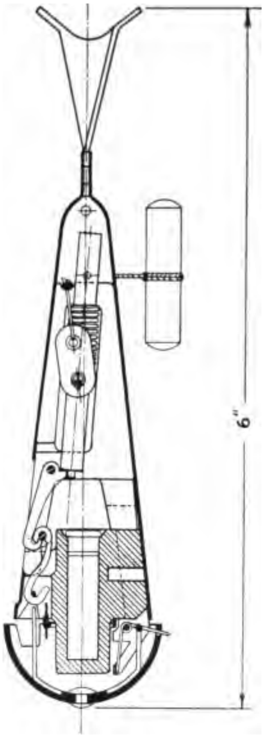


FIGURE 37.

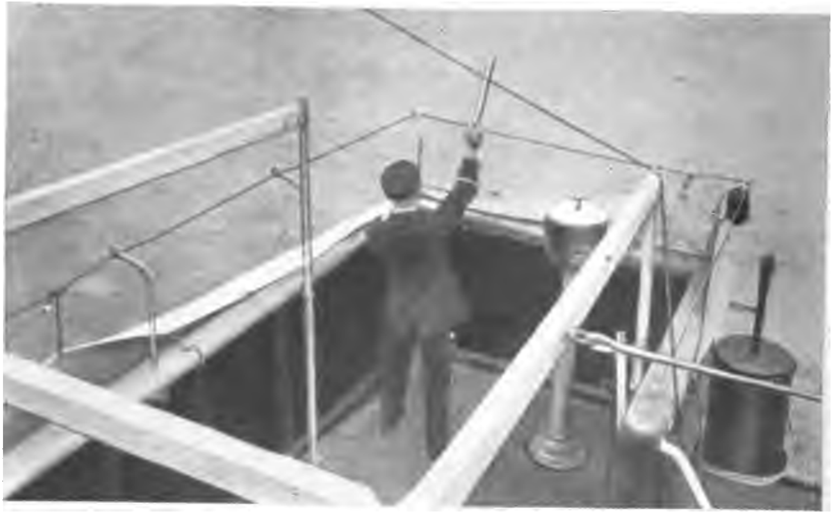


FIGURE 38.

when the explosion is heard in the telephone receiver, the sound travel time from bottom to hydrophone being neglected, then the duration of sinking will be indicated. The product of sinking time and velocity constant will give depth of water. As previously noted, the stop watch furnished with the equipment is calibrated directly in meters for the type of bomb used, so that no calculation of depth is required.

For precise depth measurement the time of sound travel may not be arbitrarily eliminated nor can the effects of temperature, salinity, and pressure be disregarded. Certain concessions must also be made in order to assume a constant rate of bomb descent. While concessions are sometimes possible in navigation, they hold but little appeal in precise hydrographic work.

OBJECTIONS TO SONIC-ECHO METHODS

While the sonic frequencies have advantages in distance of transmission and penetration, these advantages are not so pronounced, since improvements in design have so materially increased the efficiency of supersonic equipment. As sonic waves advance in a spherical front they cannot be projected in one direction only, as can a beam of light. For many applications this is a decided disadvantage.

Due to the lower frequencies, it follows that fewer soundings can be made in a given time with sonic methods. In many survey operations such a limitation cannot be tolerated. The lower frequencies are also not so well adapted, by reason of the greater length of wave, to sounding in shoal water.

Under a given set of conditions there is less accuracy possible in depth measurement with sonic frequencies than with those in the supersonic range.

The fact that sonic frequencies are audible in many cases constitutes an objection, as eventually the sound becomes annoying. An instance of this is found in the case of a dredge operating on a 24-hour schedule where one shift not on duty is attempting to sleep.

Many of the ordinary water sounds, such as the break of waves, the wash of water on shore or on submerged rocks, and the sounds caused by the movement of underwater rocks on each other, come within the sonic range. Added to these are the sounds from the engines and propellers of nearby vessels. The hydrophones used in sonic systems will respond to certain of these extraneous sounds, and this causes considerable confusion with depth measurements, as the extraneous sounds will register with or to the exclusion of the depth echo.

As sonic wave lengths are relatively long, the equipment to generate the waves must of necessity be large and bulky. This is undesirable, particularly in the smaller survey craft, where space and weight are at a premium. There are other valid objections to the use of sonic methods for depth measurement, but no attempt is made here to list any but the principal ones.

III. SUPERSONIC OR ULTRASONIC METHODS

In the historical discussion of sounding, mention was made of the work of Richardson in England about 1912. He tried to produce sounds above the audible range (supersonic) and to direct them with a reflector. As in the case of many pioneers, the state of the art at the time was such that he met with little success.

In 1914, M. Chilowsky, in France, proposed converting electricity at a frequency of 40,000 cycles per second into sound waves at the same frequency (supersonic vibrations). The object was to impart this vibrating motion to a rigid surface, such as a diaphragm, so that the surface would become a sound-radiating source. Such a conversion can be made through electromagnetism, but a converter of the microphone type was found to be of little value at the frequency used. Then Chilowsky, collaborating with M. P. Langevin, tried to make the conversion with a singing condenser circuit. This method proved impractical because the operating point was too close to condenser breakdown. About 1917 Langevin devised a method employing the piezo-electric effect in certain crystals which was discovered in 1880 by the Curie brothers. They found that certain asymmetric crystals when subjected to pressure become electrically polarized. This phenomenon was found to be reversible, for when a voltage was applied to the faces of such a crystal the physical dimensions changed. This piezo-electric effect is characteristic of many crystals, but probably the best known of these are

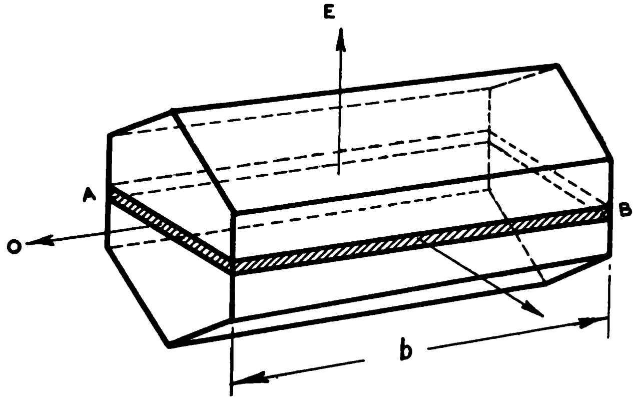


FIGURE 39.

quartz, tourmaline, and Rochelle salts. Rochelle salts give the most pronounced reaction, but mechanically they are too fragile to be of much value under the stresses of conversion service. Quartz crystals are generally used, for they have considerable mechanical strength, and while they are less sensitive than Rochelle salts they may be forced into vibrations of relatively large amplitude without damage.

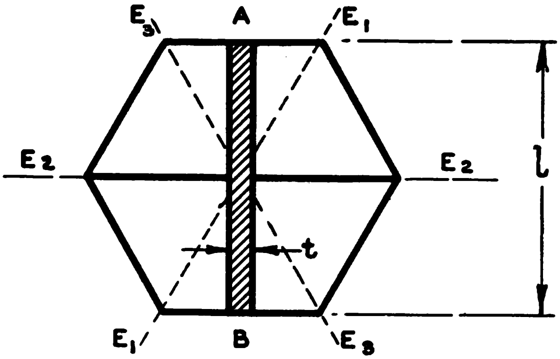


FIGURE 40.

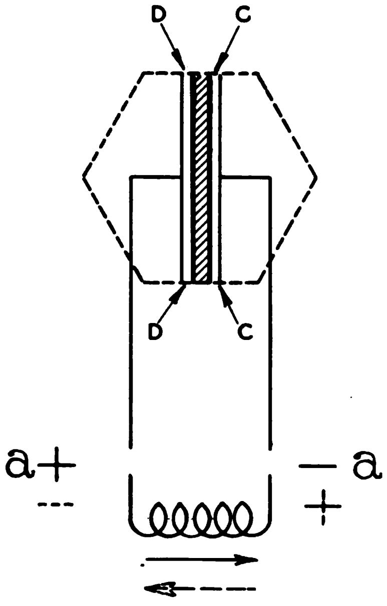


FIGURE 41.

Figure 39 represents a crystal of quartz, and figure 40 shows a cross section of the crystal perpendicular to the optical axis *O*. The electrical axes of the crystal are along the lines E_1E_1, E_2E_2, *and* E_3E_3. Plates (as *AB*) cut from the crystal have length "*l*," breadth "*b*," and thickness "*t*" as indicated. A crystal plate such as "*AB*" may be placed between metal plates, as *CC* and *DD* (fig. 41), and the sandwich thus formed connected into an electrical circuit as shown. As the quartz is electrically inert, plates *CC* and *DD* will form the plates of a condenser with the dielectric *AB* between them. Then when *AB* is compressed its piezo-electric characteristics will cause current to flow in the external circuit between *CC* and *DD*. Conversely, in the same circuit, if external voltage be applied between the metal plates, the length and thickness dimensions of plate *AB* will change. However, in this expansion or contraction the stresses are such that there is no change in the total volume of the crystal plate.

It is thus evident that when an alternating current is applied to the crystal plate it will cause corresponding stresses and strains in the length and thickness directions. When the frequency of imposed force is the same as the natural vibrational frequency of the quartz plate, then a very large resonant vibration will result. Conversely, alternate compressions and relaxations applied at a frequency corresponding to the natural crystal frequency will produce appreciable currents in a connected circuit.

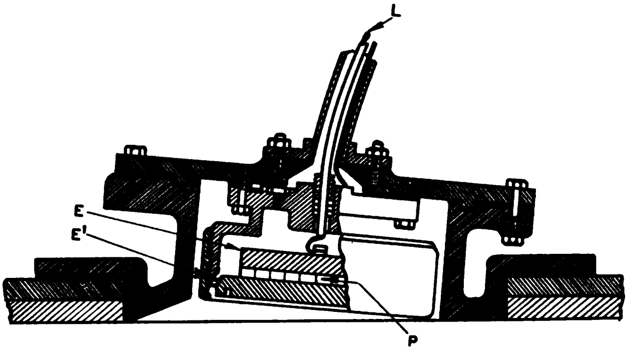


FIGURE 42.

A limiting factor in the use of quartz crystals is their small size, which makes the cut plates small and their natural frequency high.

The Langevin oscillator.—The piezo-electric properties of quartz have been employed to advantage by Langevin in the generation and reception of high-frequency (supersonic) sounds in water for the purpose of sounding and the detection of submerged bodies.

The principal construction features of a Langevin transmitter-receiver unit are shown diagrammatically in figure 42.

P is a series of quartz plates cut and ground for the desired frequency. A number of these plates are used, because a single plate of large area is costly and it is desirable to have a large radiating surface. The plate P is therefore in the form of a mosaic set between two metal plates E and E', which are also of predetermined dimensions. The quartz metal sandwich thus formed is energized by a high-frequency source which is tuned to the frequency for which the transmitter has been built. Leads L conduct currents from the source to the transmitter and from the transmitter to the receiving unit. In the Langevin system but one underwater unit is used for transmitting the sound and for receiving the echo. The echoed sound waves with pressures and rarefactions alternating at high frequency rapidly compress and relax the quartz crystal slab and thus produce corresponding electromotive forces. These small electromotive forces are conducted to the receiving unit, which is much the same as the conventional heterodyne radio receiver of today. There the received impulse becomes audible and may be indicated or recorded.

The magnetostriction oscillator.—The term "magnetostriction" includes many phenomena, all magnetic in their nature. Characterizing these phenomena are changes in physical dimensions with magnetization and, conversely, changes in magnetic properties resulting from the internal stresses of mechanical tension or compression. These phenomena closely resemble the piezo-electric effects in certain crystals which have been previously noted. Magnetostrictive effects have been found in nickel, iron, cobalt, manganese, and many of their alloys. Considerable research has been done in this field, so that reports are available in textbooks and in many technical journals.

If a bar, rod, or tube of magnetostrictive material be placed in a magnetic field it will contract. For example, when a nickel tube is placed in a rapidly alternating magnetic field it will expand and contract longitudinally and generate sound waves of double the frequency of the applied field. The frequency doubling is caused by the fact that the tube returns to its normal length during the instant that the alternating field reverses direction and then is again deformed during the following half cycle. This doubling may be readily prevented by maintaining a permanent field with a solenoid excited by direct current and superimposing the alternating field upon it. Then the length of the rod will decrease when both fields are in the same direction and increase when they are in opposition. This method has the further advantage in that the permanent magnetization moves the operating point (in the case of nickel) to a section of the magnetization curve where maximum deformation results from small changes in field intensity. The nickel may be premagnetized by a "flashing" process to accomplish this result, which renders the direct-current solenoid unnecessary. Inspection of figure 43 will show the relatively large changes in length possible within a small range of flux density on the steep portion of the nickel curve.

If the material be of such dimensions as to have the same natural frequency of vibration as the impressed alternating current, then a resonant condition will exist and the amplitude of the resultant vibrations will be a maximum. Sound waves of considerable energy and of the frequency of the applied alternating current will be radiated. Thus waves from the audible to the supersonic range may be generated. In bars, rods, and tubes of magnetostrictive material the sound is only emitted from the ends, as the vibration is longitudinal. In many applications it is desired to project the sound in a plane and uniformly in all directions. Radiation of this nature can be accomplished by an annular ring, which by magnetostriction is caused to vibrate in such a way that the radius changes periodically with the alternations in the applied electromotive force. The sound waves are then radiated in all directions from the outer edge of the annulus. In order to minimize eddy current losses, such an annular generator is usually made up of a stack of laminations suitably insulated from each other. Laminations may be punched with holes, slots, spokes, etc., for winding the wire from the magnetizing source, and in this way the radiating characteristics may be changed. By impressing electromotive forces of various phases on the separate slots or spokes other effects may be obtained for different applications.

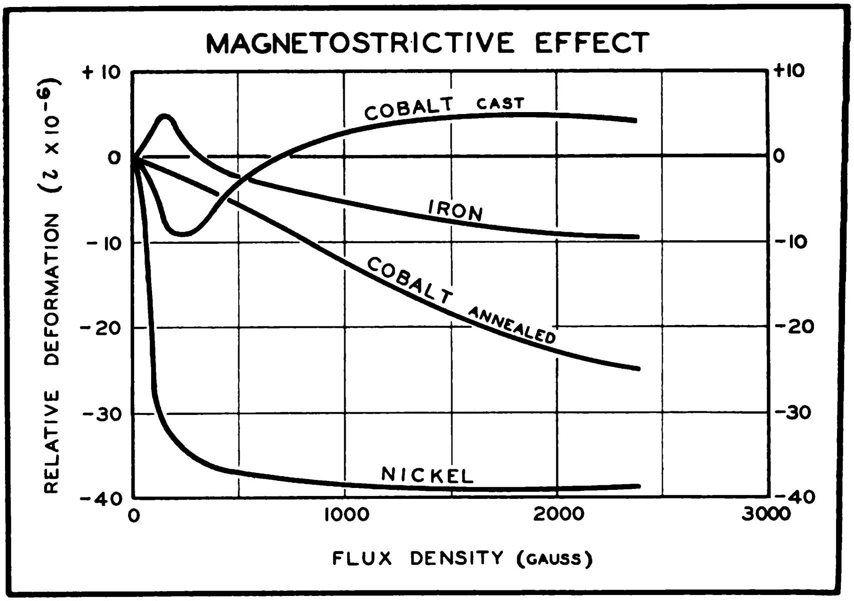


FIGURE 43.

The same principles are applied where the reverse magnetostrictive operation is desired as in the reception of sounds. The receiver may be designed for resonance at a definite frequency where maximum sensitivity is desired, or if faithful reproduction and rapid damping are paramount, then the receiver can be designed for nonresonant operation and the lack of sensitivity compensated for in greater amplification.

As in the Langevin oscillator, the same magnetostriction unit may be used for both transmission and reception. Such a double-purpose unit is called a transceiver. For some types of sounding this is an advantage, but for work at shoal depths it is seldom feasible.

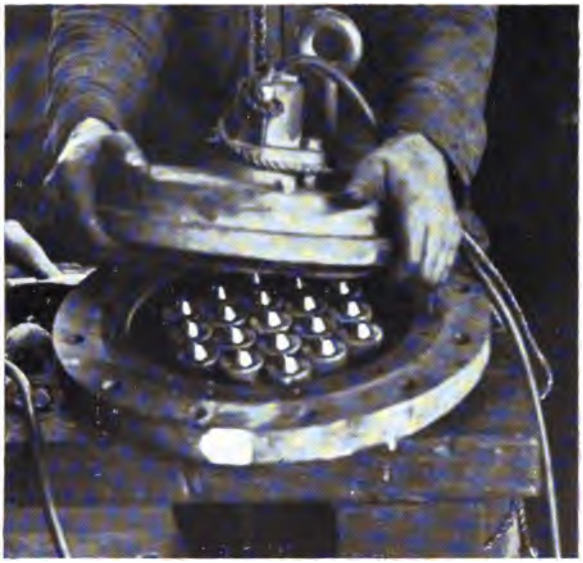


FIGURE 44.

Before proceeding to describe any specific types of supersonic apparatus it is important to dwell for a moment upon two of the underlying principles which render supersonics so applicable to precise sounding.

The first principle has to do with the directional effect, which is somewhat analogous to the effect obtained with the point source, the reflector, and the lens in a searchlight. If the wavelength of the sound is large compared to the diameter of the diaphragm, the emitted waves will have a spherical front, but if the wavelength is small in comparison to the diaphragm diameter, then the waves will be radiated as a narrow beam.

The second principle has to do with the energy radiated by the transmitter and the sensitivity of the receiver. When the frequency of the alternating source is the same as the natural frequency of the quartz sandwich or the nickel stack there exists a condition of resonance and we have the maximum efficiency of conversion resulting in vibrations of large amplitude and great energy. It is to this maximum conversion at resonance that we owe much of the effectiveness of supersonic waves. The same is likewise true of the reverse conversion in reception.

Figure 44 is a view of the transceiver unit which is a part of the Dorsey fathometer as used in the precise hydrographic work of the United States Coast and Geodetic Survey. Here the case is shown open to indicate the construction. The magnetizing element consists of a number of solenoids each placed around a nickel rod or spindle, and each spindle is firmly attached to the steel diaphragm. The diaphragm is mounted in the hull of the vessel so that it forms an integral part of the skin. The vibrations of the various spindles are transmitted directly to the diaphragm and thence to the water. The sound echo returning from the bottom strikes the diaphragm and the reverse conversion takes place.

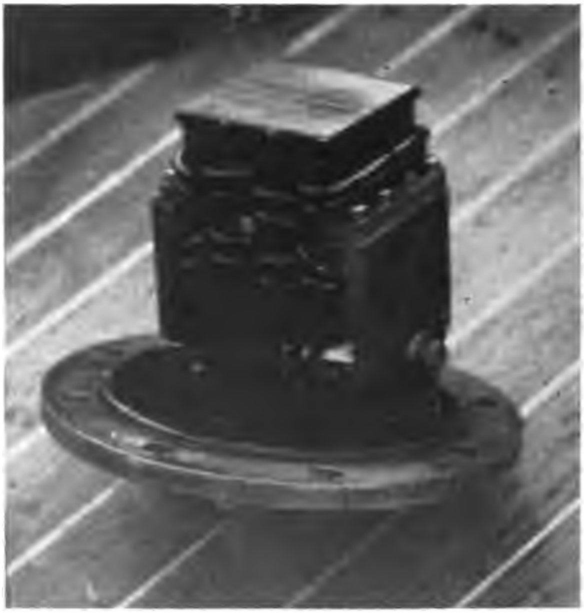


FIGURE 45.

Figure 45 is a view of a commercial magnetostriction oscillator with its enclosed case removed. It consists of a stack of rectangular nickel laminations with the magnetizing wires wound in and out of the stack as shown. The laminations are insulated from each other by coating each with an insulating varnish or cement or by a suitable heat-treating process. The laminations are stacked so that the bottom surface consists of edges as the sound is radiated from the edges of each nickel sheet.

A unique feature of this design is the swivel mounting of the nickel stack. By means of this swivel the axis of the stack may be maintained at the desired angle to accommodate (within reasonable limits) the dead-rise angle of the hull. Where the dead-rise angle exceeds this adjustment, suitable fairwaters must be provided on the hull surface.

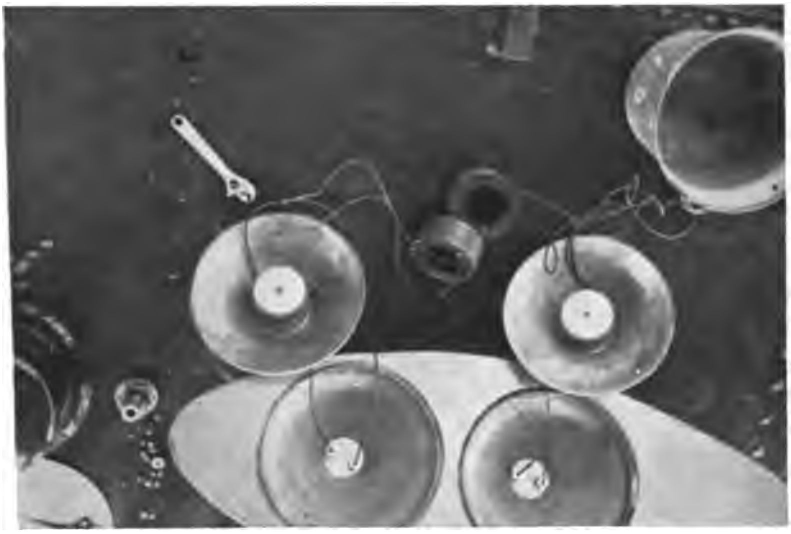


FIGURE 46.

Figure 46 shows the elements of another commercial oscillator.

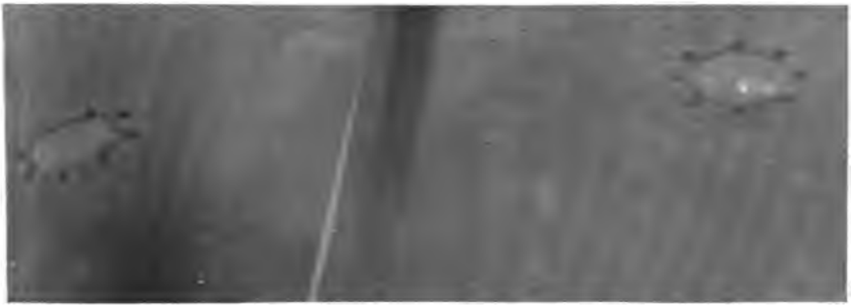


FIGURE 47.

The case is filled with liquid (generally a neutral oil or water) and the oscillations are transmitted through the medium to the diaphragm in the case and thence to the water. Such units are made for insertion in hull plates, as in figure 47, or may be mounted in pairs in a streamlined case for outboard use as in figure 48.

[illegible] oscillator [illegible]

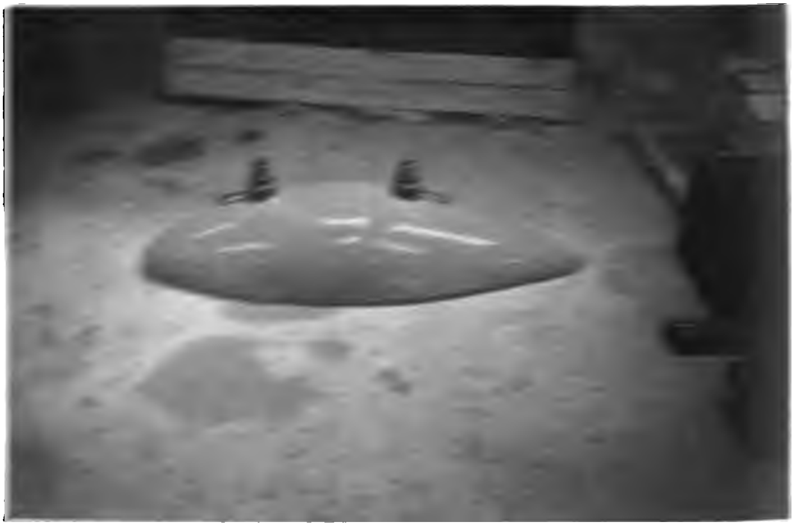


FIGURE 48-A.

[illegible]

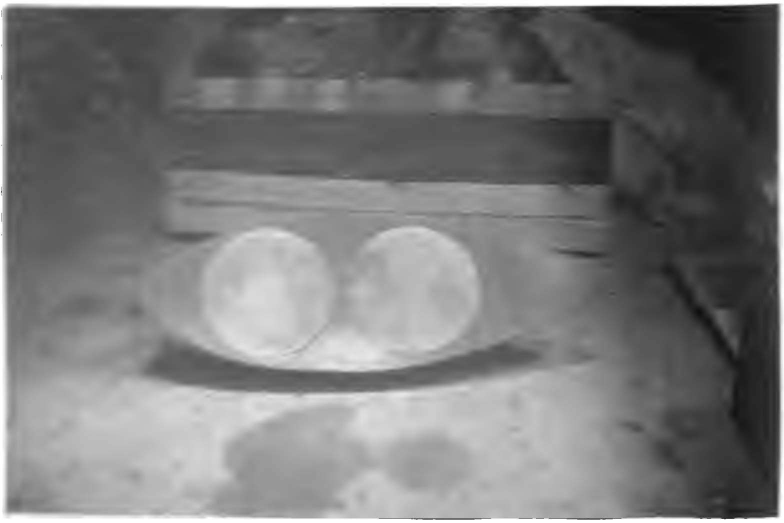


FIGURE 48-B.

[illegible] outboard oscillator unit shown in figure 48-A is [illegible] a pipe mounting for support and to serve as a conduit for lead wires. The support is arranged with sliding members to provide an adjustment for depth of immersion and the sliding members fit into a bracket on the side of the vessel. Figure 48–B shows the oscillator diaphragms in the bottom of an outboard unit, and figure 49 shows the pipe support and bracket mounting on the side of a survey vessel.

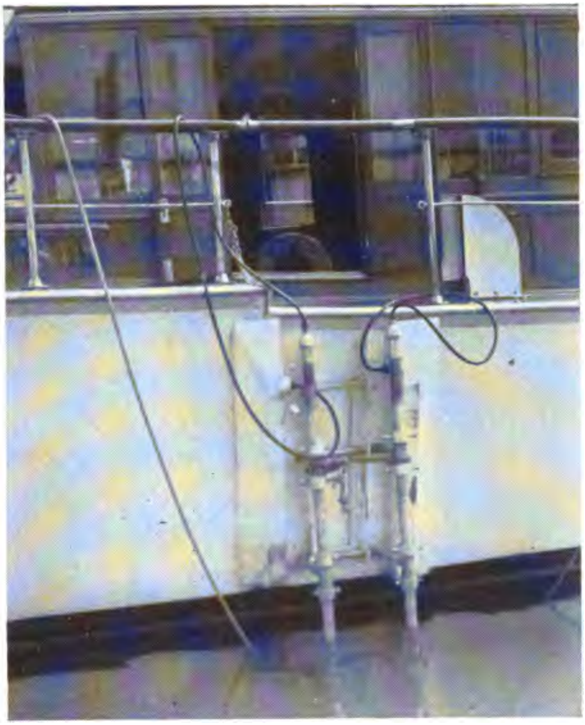


FIGURE 49.

ADVANTAGES OF SUPERSONIC FREQUENCIES IN SOUNDING

Since about 1918 great advances have been made in the science of acoustics, which hitherto had been generally neglected. In spite of these advances much remains to be done, and a fair share of this unfinished business lies in the supersonic field. Thus the advantages of today may be further amplified tomorrow.

Due to the ratio between wavelength and radiating surface the supersonic waves are in the form of a highly directional beam. This is desirable, as it restricts the area covered per sounding and makes the location of questionable spots more definite. The higher frequencies make more soundings possible per unit of time and thus expedite survey operations.

Because of the shorter wavelengths the supersonic system can be used in much shallower depths than is possible with the sonic system.

Also, due to the shorter wavelengths involved, the system is capable of more accuracy than the greater sonic wave lengths.

In survey work the silent operation of the supersonic system is an advantage, as the intermittent hammering of the sonic transmitter will in time become annoying.

With the higher frequencies (short wavelengths) a great amount of energy may be radiated without making the source amplitude too great. Space requirements are not so great, and particularly in small survey craft the bulk of a sonic sounding equipment is not in its favor.

The majority of water noises, such as wave wash, breaking waves. propeller and engine noises from other vessels, and the like, are within the sonic range, so that supersonic equipment is comparatively free from such interference.

SUPERSONIC DEPTH INDICATORS

There are several supersonic indicating systems commercially manufactured and on the market today. While they differ in certain details of design they are without exception simply automatic devices to measure very short time intervals accurately. The salient features of some of these systems will be described.

1. *The Submarine Signal system.*—The indicators manufactured by Submarine Signal Co. are commonly known as fathometers, a trade name which has gained wide acceptance in this country.

The outstanding feature of the fathometer is the rapidly rotating disk with the narrow radial slot, behind which is mounted a neon tube. The rotating disk is driven by a motor from a direct-current supply line of regulated voltage. The motor speed is regulated by a governor of the centrifugal type attached to the motor shaft. As the radial slot in the driven disk passes the zero point on the depth scale a cam-operated contact closes, discharging a condenser through the winding of the transmitting oscillator thus projecting a train of supersonic waves from the diaphragm in the hull of the vessel. This sound travels through the water and upon striking the bottom is reflected back toward the surface. A portion of this echoed wave strikes the diaphragm of the receiving oscillator, is there rapidly converted from mechanical to electrical energy and conducted to the electronic amplifier (a second unit of the equipment). The amplified impulse is conducted to a transformer in the indicator and from there to the neon tube behind the radial slot in the moving disk. Between the transmission (at zero) and reception of the impulse the disk has rotated through an angle in proportion to the elapsed time. Thus the flash of the neon tube acts as a moving pointer or index and the scale reading from zero is a true measure of the depth of water from the oscillators to the bottom. The depth scale is made on a one-half ratio, as the distance traversed by the sound wave is actually twice the depth. Due to the fact that the oscillators are in the hull of the vessel, and therefore beneath the water surface, a constant must be added to each indicated reading if depth of water from bottom to surface is required.

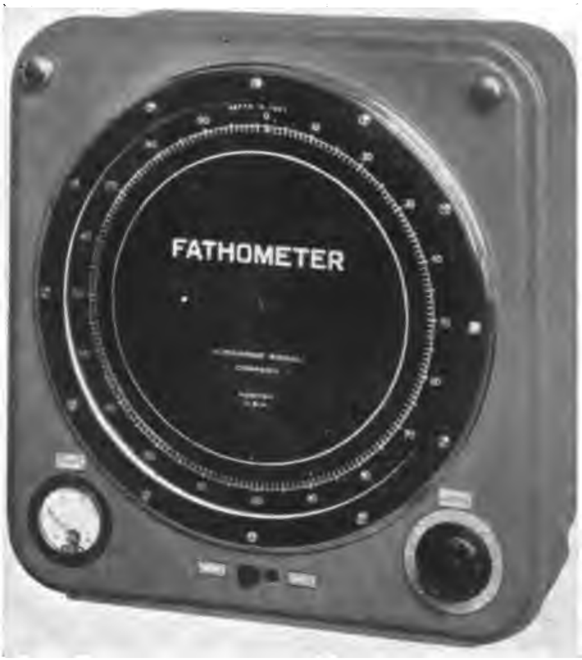


Figure 50.

In figure 50 the dial at the lower right controls the sensitivity or gain of the amplifier, the left-hand dial is a voltmeter across the line, and the toggle switch in the lower center is used to stop and start the whole equipment. A better idea of the internal construction of the indicator may be gained from inspection of figure 51. Mounting the operating elements on the front panel adds much to the ease of adjustment and repair.

The depth range of the model shown is 0 to 200 feet, and the same company manufactures other models of various ranges.

The condenser with the charging dynamotor and discharging relay are contained in a separate unit called the "driver."

Some specialized designs of fathometer indicators for precise shoal-water survey work will be considered later.

2. *The Husun (Admiralty) system.*—The Husun indicating apparatus employs under-water units of the magnetostriction type. The received impulse is amplified and used to discharge a condenser through a moving coil system actuating the pointer, which passes over a calibrated scale as shown in figure 52, thus indicating the depth.

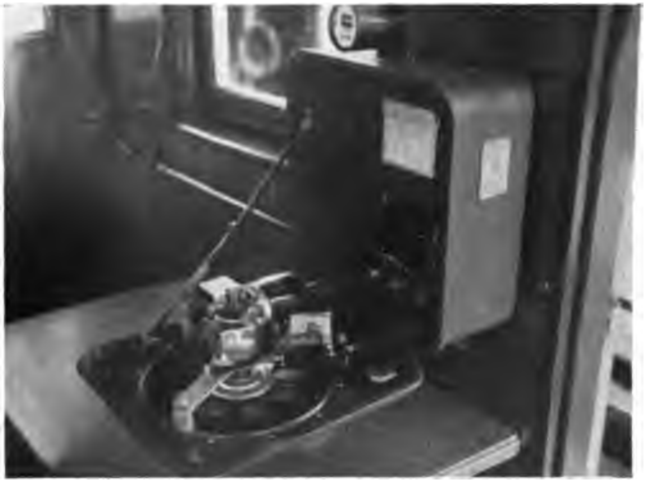


FIGURE 51.

3. *The Marconi system.*—The Marconi system employs magnetostriction, and the oscillator units are somewhat similar to those of Husun except that the individual nickel laminations are rectangular. The laminations are stacked horizontally so that reflectors are used to project the impulses downward.

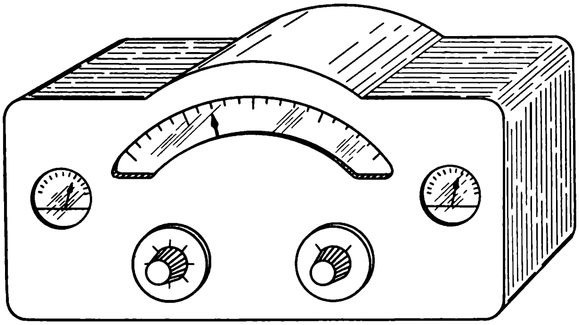


FIGURE 52.

The Marconi depth indicator is essentially an oscillograph in which a mirror is attached to the moving element. A spot of light focused on this mirror is reflected by it onto another mirror which is rotated at a constant speed of 60 revolutions per minute. From the rotating mirror the light spot is reflected to the calibrated indicating scale, so that as the mirror turns the light spot is seen to move along the scale at a rate of one complete traverse per second. Whenever an impulse is received it is suitably amplified and conducted to the oscillograph. A deflection of the moving element causes the light spot to be deflected from its normal straight path across the scale and gives the visual effect of a peak in the light track. The position of the peak on the scale can be read in terms of depth against the scale divisions. Adjustments are provided so that the peak resulting from the direct impulse reception (i. e., direct from transmitting oscillator to receiver through the hull or through the water) can be set at zero on the scale. Then, since the elapsed time between transmission of the impulse and reception of the echo is proportional to the depth of the water, the indicating scale is calibrated directly in feet, fathoms, or meters. The scale is horizontal and shaped in the form of an arc so that divisions will be uniform.

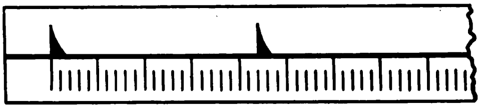


FIGURE 53.

Figure 53 shows how the peaks appear on the indicator scale, the one at the left being the direct, or zero, impulse and the one near the center being the depth echo.

4. *The Langevin-Florisson-Touly* (*S. C. A. M.*) *system.*—In this system the quartz crystal transceiver unit is used. This unit is shown in figure 42. The visual depth indicator together with the control box is termed the Florisson optical analyzer. This unit employs a light beam which is projected into a hollow cylinder having a helical slot in its side extending the full length. The cylinder is rotated by a synchronous motor from a tuning fork supply for accurate timing. From the helical slot the light comes through a lens which focuses it on a vertical scale. The returning echo is received, amplified, and conducted to the optical analyzer. There the impulse causes the light beam to be displaced from the axis of the cylinder, which causes a peak to appear in the image on the scale. As the transmission is timed to zero on the scale the peak in the light track will indicate depth on the calibrated scale. Later models of the S. C. A. M. sounder employ an indicator closely akin to the Submarine Signal type, with the rotating disk driven by a governed motor. A flashing neon tube behind a radial slot indicates the depth.

5. *The Atlas Werke system.*—Atlas Werke, of Bremen, was formerly associated with Submarine Signal Co., and the products of

the two companies were much similar. More recent developments in the art in Germany are not widely known. The same situation also applies to Debeg, of Hamburg, and Electroacoustic, of Kiel.

SUPERSONIC DEPTH RECORDERS

1. *Marti* (*S. I. E. R.*) *system.*—The older Marti recording depth sounders were constructed as shown in figure 34 and used a smoked-paper chart. Later models were improved in various respects, and at one time the record was made in ink on a clock-driven chart. More recent models have used a reciprocating cam-driven stylus arm about 12 to 15 inches long suspended from a pivot. The cam is driven by a governed motor mounted vertically.

The record is made upon a wet, chemically processed paper.

The S. C. A. M.-Touly recorder and also the Marconi recorder appear to be much like the Marti model and are possibly adaptations of it.

2. *The Husun* (*Admiralty system*).—Henry Hughes & Son manufacture recording echo sounders for both deep-sea and shoal-water applications. The recorders for deeper water, where greater time intervals are involved, use a reciprocating type of stylus carriage and a rectilinear chart on a chemically processed paper which is damp when the record is made.

Such a deep-water or navigation model is shown in figure 54. The purpose of the black dial on the case to the left of the chart is to increase the recording range in even steps of a fraction of the basic chart range. For example, with a basic chart range of 90 fathoms and four additional range steps of 50 fathoms each, the total over-all range would be 290 fathoms, but on the last step the sounder would only record depths within the range of 200 to 290 fathoms, as shallower depths would come beyond the edge of the chart paper. This method of range shifting is called phasing. In survey work phasing is generally preferred to increasing the over-all range on the chart, as it retains the desirable feature of an open scale. Phasing is accomplished by simply setting back or depressing the zero or transmission point by such an amount that the active part of the total depth range comes on the chart for recording. A change of total range by any multiple is generally accomplished by gearing to increase or decrease stylus arm speed by the required factor. Thus a range change from feet to fathoms is made by a 6-to-1 reduction in the stylus arm drive.

Charts for recorders of the type shown in figure 54 are generally furnished in rolls in the dry state. The recorder is provided with a small water tank, through which the paper passes. From the tank the paper passes over a squeegee bar to remove excess water, then under the stylus, where the record is made; and finally under a small electric heater coil to dry the chart before rerolling.

For more precise work in shoal depths Henry Hughes & Son have developed a high-speed recorder. The high-speed operation is obviously necessitated by the shallow depths involved.

One of these recorders with the case open is shown in figure 55. The stylus arm is continuously rotating, and thus the depth recordings and calibration lines take the form of arcs of the same radius as the stylus arm. This causes the depth scale to appear contracted at the low and high ends, whereas along the arc of stylus travel it is actually uniform.

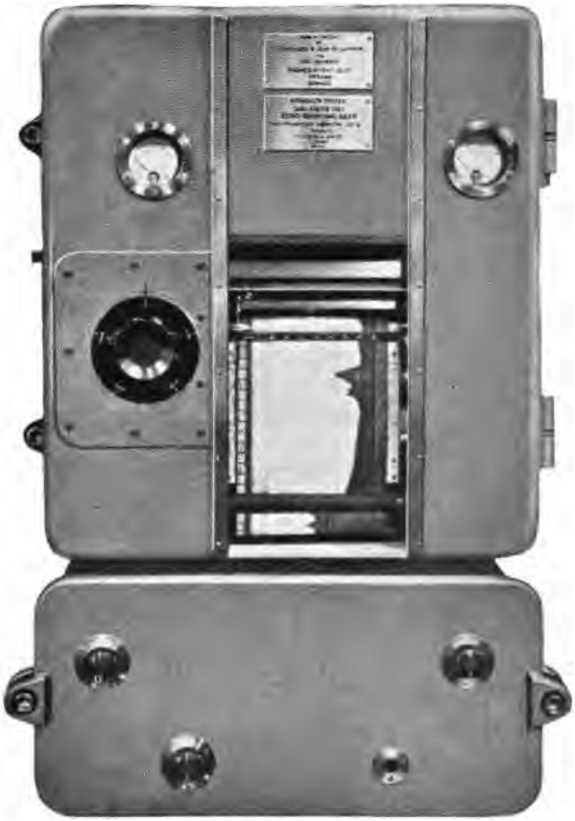


Figure 54.

As the chart paper is damp at the time the depth record is made, an arc-shaped contact switch is incorporated in the machine so that calibration dots are also made on the chart during the recording process. It is admitted that the chart will shrink upon drying, but with the arrangement noted the calibrations shrink by the same amount that the depth record does, so that the relative values do not change. However, the damp paper does introduce problems both in handling and in the charting of depths from the dry record, so that the system in this respect is not ideal. Considerable effort has been made to keep the unit light in weight, as many survey operations can best be accomplished with portable sounding equipment. Models have been installed for operation on 12 volts, direct current, with B batteries for amplifier plate supply. With such portable equipments the outboard oscillator is frequently used, as it is ideal for the purpose. An oscillator of this type is shown in figure 48–A.

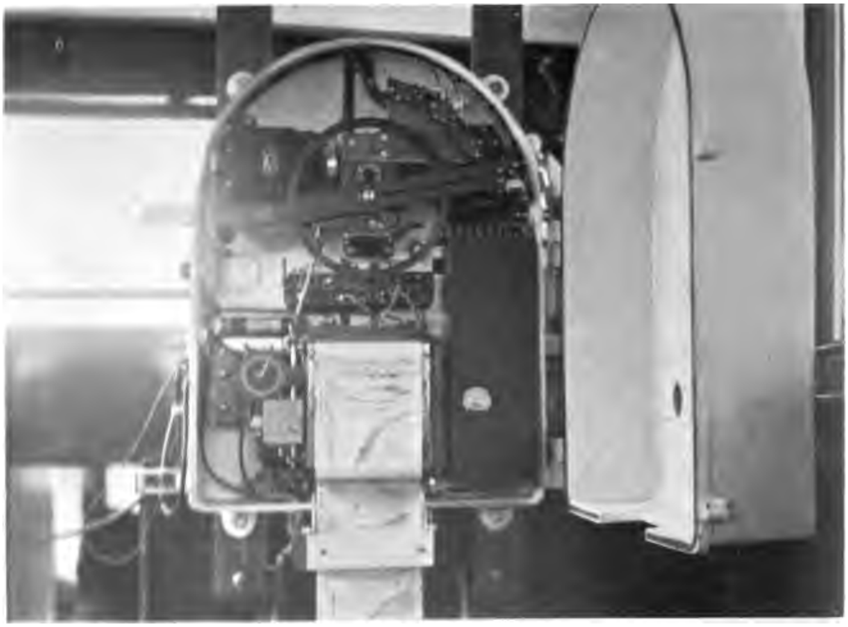


FIGURE 55.

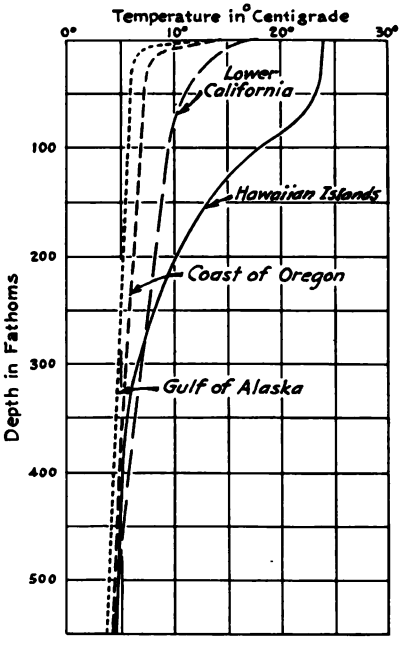
ERRORS INVOLVED IN SUPERSONIC ECHO SOUNDING

While supersonic methods have much to recommend them, they are not free from error, and some of the more frequently encountered errors will be noted, together with the means employed to either eliminate them or to tolerate and compensate for them.

Temperature error.—As noted previously in this text, the velocity of sound in water varies with temperature, dissolved solids (salinity), and pressure. As these variables are not linear functions, except over relatively short ranges, automatic compensation for them becomes complicated, and other means have been resorted to which satisfy the requirements of most field survey work. The decision as to whether any compensation at all is required must be based entirely upon the accuracy which the nature of the soundings demands.

Hydrographic survey work which is primarily of the reconnaissance type seldom requires that much compensation be applied, whereas the detailed work for charting or for checking dredging performance calls for such precision as to make compensation imperative.

In a mass of water the temperature gradient will be from a minimum at the bottom to a maximum at the surface and generally in the form of various layers or strata. In the ocean it has been determined that at about 450 fathoms a minimum is reached. This is shown graphically in figure 56, which is reproduced from data of the United States Coast and Geodetic Survey.



TEMPERATURE-DEPTH CURVES

FIGURE 56.

A thermometer of special design is used for taking temperature readings at various depths, and from these data mean values are derived for compensation. A so-called reversing thermometer is in general use for taking temperatures at various depths, as it has been designed for this type of service. Authoritative tables of sound velocity for different values of temperature, salinity, and pressure are published by the Hydrographic Department of the British Admiralty.

amount that the depth record does, so that the relative values do not change. However, the damp paper does introduce problems both in handling and in the charting of depths from the dry record, so that the system in this respect is not ideal. Considerable effort has been made to keep the unit light in weight, as many survey operations can best be accomplished with portable sounding equipment. Models have been installed for operation on 12 volts, direct current, with B batteries for amplifier plate supply. With such portable equipments the outboard oscillator is frequently used, as it is ideal for the purpose. An oscillator of this type is shown in figure 48–A.

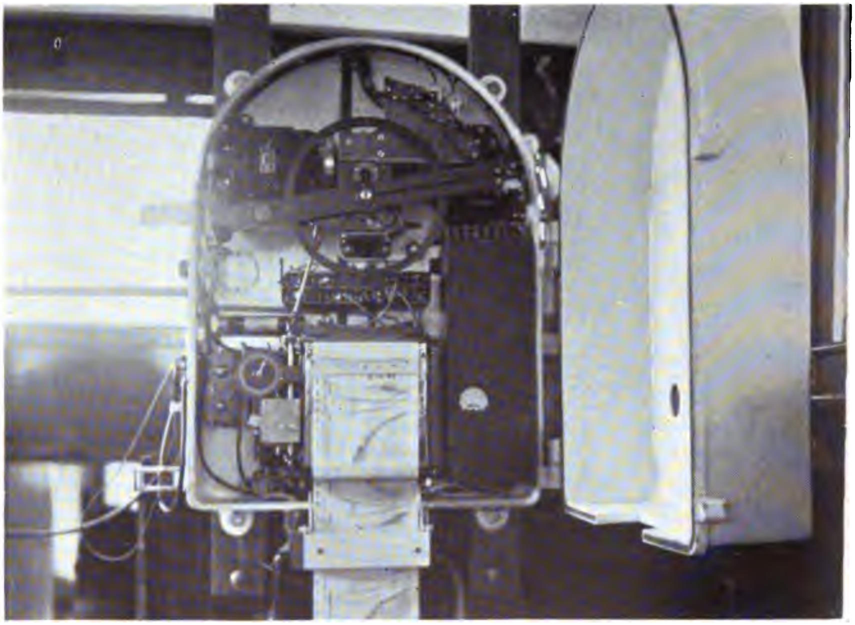


FIGURE 55.

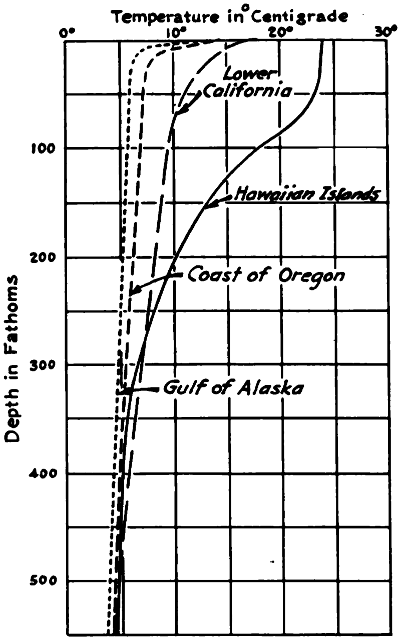
ERRORS INVOLVED IN SUPERSONIC ECHO SOUNDING

While supersonic methods have much to recommend them, they are not free from error, and some of the more frequently encountered errors will be noted, together with the means employed to either eliminate them or to tolerate and compensate for them.

Temperature error.—As noted previously in this text, the velocity of sound in water varies with temperature, dissolved solids (salinity), and pressure. As these variables are not linear functions, except over relatively short ranges, automatic compensation for them becomes complicated, and other means have been resorted to which satisfy the requirements of most field survey work. The decision as to whether any compensation at all is required must be based entirely upon the accuracy which the nature of the soundings demands.

Hydrographic survey work which is primarily of the reconnaissance type seldom requires that much compensation be applied, whereas the detailed work for charting or for checking dredging performance calls for such precision as to make compensation imperative.

In a mass of water the temperature gradient will be from a minimum at the bottom to a maximum at the surface and generally in the form of various layers or strata. In the ocean it has been determined that at about 450 fathoms a minimum is reached. This is shown graphically in figure 56, which is reproduced from data of the United States Coast and Geodetic Survey.



TEMPERATURE-DEPTH CURVES

FIGURE 56.

A thermometer of special design is used for taking temperature readings at various depths, and from these data mean values are derived for compensation. A so-called reversing thermometer is in general use for taking temperatures at various depths, as it has been designed for this type of service. Authoritative tables of sound velocity for different values of temperature, salinity, and pressure are published by the Hydrographic Department of the British Admiralty.

It is important to recognize the fact that temperature errors cannot be neglected in the usual hydrographic survey routine nor can a spot temperature be assumed as a working mean from surface to bottom.

As sound-velocity tables consider temperature and salinity together, methods of compensating for both variables will be considered after discussion of the salinity error.

Salinity error.—The velocity of sound in water also varies directly with the amount of dissolved solids in the water (salinity), but errors of this nature are of smaller magnitude than are temperature errors.

The inland waterways seldom present any salinity problem, and variations at sea are generally of small consequence for a given survey area. However, the tidal waters of harbors and estuaries are frequently subject to such ranges of salinity as cannot be tolerated without compensation if the survey makes any claim to precision.

British Admiralty tables HD-282 contain the necessary velocity data for applying corrections when the salinity and temperature have been determined.

Salinity determinations are generally made with a hydrometer having a specific-gravity scale. Conversion tables provide a means of transferring these readings into terms of salinity (parts per thousand). Salinity may also be determined by other means—such as chemical titration, optically with a form of refractometer, or electrically by measurement of conductivity—but these alternatives are seldom adaptable to field conditions.

Pressure error.—Values of pressure have been calculated for various ocean depths, and the corrections to be applied to sound velocity due to pressure will be found in published tables. For shoal-water survey work the pressure errors are so small that for all practical purposes they may be ignored.

COMPENSATION FOR TEMPERATURE AND SALINITY ERRORS

In the design of sonic and supersonic-echo sounding indicators and recorders a definite range of sound velocities is provided for; and then, in final adjustment during the course of manufacture, a standard speed of rotation for the indicating means or the recording stylus is assumed for uniformity. This standard speed is generally marked on the name plate of the instrument itself or noted in the operating directions, together with the sound velocity to which the speed corresponds. Having determined the temperature and salinity of the water in the survey area under consideration and from those data the corresponding sound velocity, it is but a matter of proportion to calculate the proper speed of rotation for the sounder. Thus.

assuming a velocity of 4,800 feet per second and a stylus arm speed of 200 revolutions per minute, we have the proportion $\frac{S}{S^1}=\frac{V}{V^1}$ in which

S is the required stylus arm speed.
S^1 is the standard stylus arm speed.
V is the sound velocity as calculated for the area.
V^1 is the standard sound velocity.

Assuming S^1 to be 200 revolutions per minute, V^1 to be 4,800 feet per second, and V to be 4,900 feet per second, we find the proper stylus arm speed to be 204 revolutions per minute. On most of the centrifugal motor governors an adjustment is provided for the contact spacing so that the governed speed may be changed in accordance with sound-velocity changes. For many hydrographic operations an adjustment of this kind with a hand tachometer or a revolution counter and stop watch is sufficiently accurate.

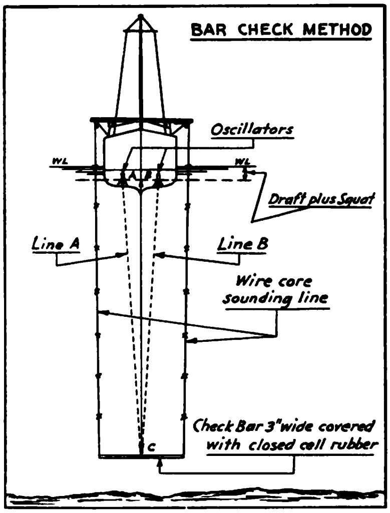


FIGURE 57.

A novel method of compensating for temperature and salinity errors, without recourse to any direct measurement of either factor, has been used successfully in England. This simple yet effective method is called the bar check, and the elements of it are shown in figure 57.

The essence of the scheme is the creation of a false bottom from which echoes may be obtained. This false bottom may be set at any desired depth and survey conditions as to temperature and salinity simulated. As it is highly important to avoid catenary in the lines from which the check bar is suspended, such checks should only be made in areas where the water is quiet on the surface and free from lower strata of any appreciable velocity. A stiff bar of steel or aluminum alloy with a **T** cross section has been found satisfactory, but much sharper echoes can be obtained if the reflecting surface is covered with a sheet of rubber having enclosed cells filled with air or gas. The greater density difference of water to air as opposed to water to metal is the cause of the sharper echo.

The check bar is dropped under the hull of the survey vessel and held at the required depth laterally or athwart the vessel directly under the oscillators. Then the indicator or recorder should read the same depth as the bar-supporting lines, less the depth of oscillator immersion (generally the draft or the draft plus squat of the vessel). If the indicated depth and line depth do not agree, then the difference can be accounted for in temperature and salinity errors. The compensation may readily be made by adjusting the governor of the drive motor until the two depths are the same. Then as long as temperature and salinity conditions remain constant the indicated or recorded depths will be true. Although empirical in its nature the bar check is accurate if ordinary precautions are observed. At depths in excess of 50 feet not only are catenary errors in the support lines apt to become excessive but it becomes increasingly difficult to maintain the bar directly under the oscillators. Such a checking method is therefore applicable primarily to shoal-water work.

Separation or base-line error.—Most of the echo-sounding equipments which operate on the magnetostriction principle use separate units in the hull of the vessel for projecting and receiving the sound waves. Reference to figure 57 will show that the sound waves travel over the path of line A and line B from the projector to the bottom and thence to the receiver. The angle included between lines A and B is small, but nevertheless the total distance by that path is somewhat greater than twice the vertical distance from the oscillator plane to the bottom. Knowing the separation of the oscillators and the indicated depth, the separation error may be readily calculated from the relation:

$$E=\sqrt{D-\sqrt{D^{2}-\left(\frac{S}{2}\right)}}^{2}$$ in which

E = the separation error in inches.
D = the indicated depth in inches.
S = distance between oscillators (center to center) in inches.

From this relation it is obvious that for the usual oscillator separation of 2 to 4 feet the error in depths of over 10 feet is so small as to be well within the guaranteed accuracy of the equipment and hence negligible. When a standard separation is adopted the depth scale may be calibrated at the shoal end to compensate for the error.

Squat error.—This error refers to the tendency of the hull of the vessel to sink deeper into the water when under way. It is a function of the hull shape, draft, and depth of water, as well as of propulsion speed. The squat effect is illustrated in figure 58. It will be noted that at the usual location of oscillators the effect is not large, and it may be a positive or a negative error. In any case the squat error is usually known within the range of survey speeds and the correction is applied to the draft (to the plane of the oscillators). Then the draft plus squat correction can be applied to all soundings if depth from bottom to water surface is required.

Water-level error.—Tides and river stages come under this general heading, and while errors due to these variables are in no sense caused by any deficiency of the sounding machine, still they must be accounted for in hydrographic survey work. As charts and dredging contracts refer to a standard datum plane, it follows that the soundings must also be thus standardized to be of any value.

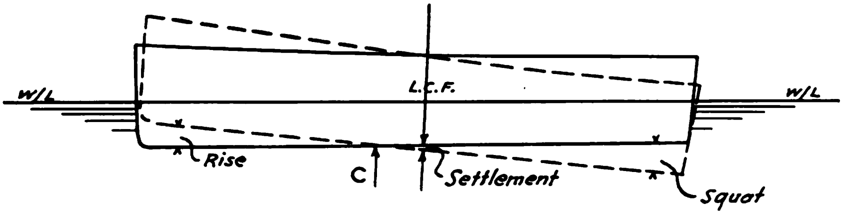


FIGURE 58.

Tide gage readings may be applied mathematically to the soundings before charting, or another expedient which has recently been incorporated into the United States Engineer Department survey technique is to apply the compensation directly in the echo sounder so that the readings may be plotted without correction. This method will be discussed later.

In the foregoing discussion the possibilities of error have been by no means exhausted, but many of the other errors are infrequent or transient in their nature and thus of but passing interest in the general consideration of the subject.

ECHO SOUNDING DEVELOPMENT IN THE UNITED STATES ENGINEER DEPARTMENT

The interest of the United States Engineer Department in hydrography may perhaps be best explained by a quotation from a letter written in 1876 to the Secretary of War by Gen. A. A. Humphreys, then Chief of Engineers.

> From the earliest period, the several organizations of Engineers which we have had in our service have invariably and exclusively made the surveys for,

and the plans of, our seacoast defenses, whether of a temporary character, which were built up to 1818, or of the permanent character which have been since that time projected, and have superintended their construction and the disbursement of the funds appropriated by Congress for the same.

Up to about 1831, its officers were to a great degree the repositories in this country of the knowledge which was requisite for the purpose of making surveys. The location and construction of the roads, canals, and bridges built for the development of the resources of the country, and the accurate methods of surveying—geodetic, topographic, and hydrographic—now in use, are in a great measure due to the talents and labors of its officers.

Almost all the great routes of internal communication in the interests of commerce and speedy transit now in existence in the country were first explored, located, and projected by officers of this corps. The files of the Bureau of the corps in Washington and the congressional documents are rich in reports upon the works of this character which have been examined by the Corps of Engineers.

In the matter of the improvement of rivers and harbors and in the interest of commerce the Corps of Engineers has had almost exclusive control, and the information on this subject contained in reports of its officers, from the early years of this century to the present time, now filed in the Bureau of the corps, is a monument to its labors and a most valuable collection of precedents to be used in the future prosecution of such works.

That the interest of the Department has been alert, active, and progressive is well exemplified in the contributions of such men as C. McD. Townsend, Montgomery Meigs, F. C. Shenahon, and many others whom the history of the art has not recorded by name. The shoal-water pressure sounder and the various shoal-water sounding wheels, both manual and power-driven, are outstanding contributions to the science of sounding. Such developments are no less important because they must be credited to the Department at large.

The entrance of the United States Engineer Department into the field of echo sounding dates back to about 1928, when a sonic equipment was purchased from Submarine Signal Co. for installation on a survey vessel in the Lake Survey District. This vessel was engaged in hydrographic survey operations on the Great Lakes, where, due to the greater depths, a sonic equipment could be used to advantage. The equipment has been overhauled from time to time and installed upon a new survey vessel, but it is still in active service. This indicating fathometer is shown in figure 59.

Other instruments of the sonic type have been tried for survey work in shoal water, but results have not been uniformly encouraging. In 1936 and 1937, after the advent of a new high-speed depth indicator of the supersonic type, the Department purchased several equipments for use in district hydrographic survey operations. With the exception of one, which has been replaced with a later model, these units are all in active use. These indicators are similar to the one shown in figure 50. It was found that with a unit such as this, providing 720 soundings per minute, the entire sounding technique must be speeded up in order to gain the benefit of the advantages inherent in the system.

In 1938 two Dorsey No. 1 fathometer indicating units were purchased and installed on survey vessels of the Department. These equipments employ a single transmitter-receiver unit (transceiver) in the hull of the vessel, which eliminates the separation or base-line error entirely. They also operate on a frequency which is controlled by a tuning fork, so that the motor governing problem ceases to be a major one.

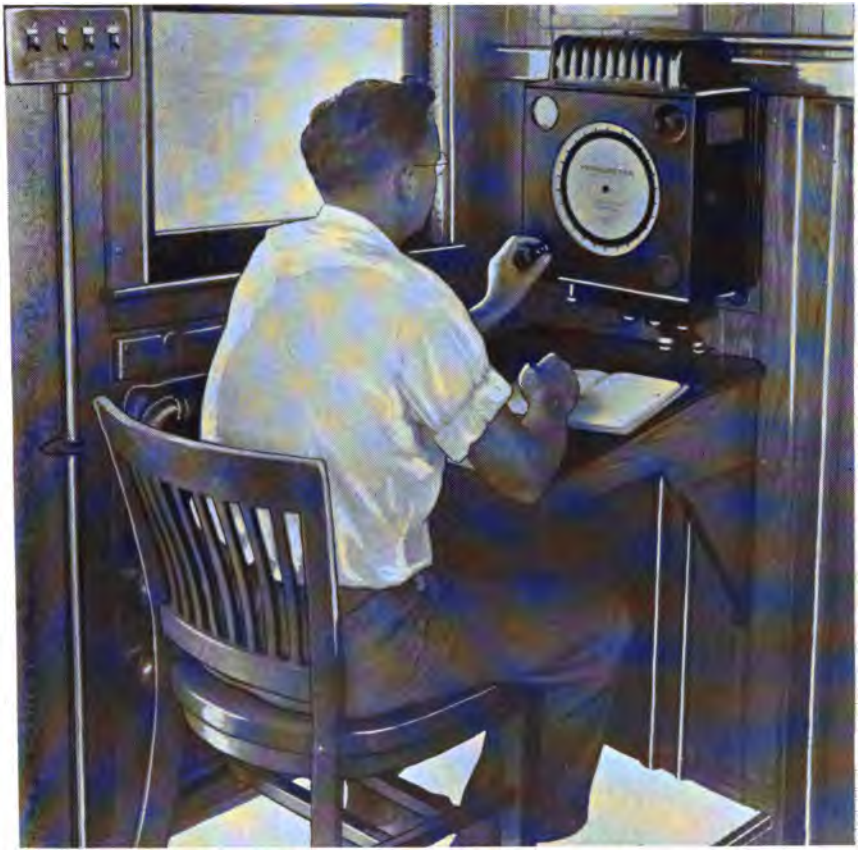


FIGURE 59.

One of the Dorsey installations is shown in figure 60 with the indicator above the desk and the electronic amplifier below.

The power-supply panel assembly of this installation, including the tuning fork, is shown in figure 61 as it was mounted below deck. The transceiver, shown partially assembled in figure 44, was mounted in a fairwater on the hull of the vessel in order to assure vertical projection of the sound waves. This equipment, as the name implies, was designed by Dr. H. G. Dorsey, of the United States Coast and Geodetic Survey, for use principally in off-shore precise survey work. For Engineer Department use in the lesser depths of rivers and harbors it was found that the shorter time intervals did not permit the transceiver to function properly. Furthermore, while the centrifugal motor governor is not ideal it does have definite advantages in simplicity and bulk over this alternative of a fork-controlled frequency. An additional advantage of primary importance is the flexibility of the governor, as that feature provides such a ready means of temperature and salinity compensation. It was therefore concluded that for the purposes of shoal-water surveys in the Department the choice lay in favor of the centrifugal governor and two separate under-

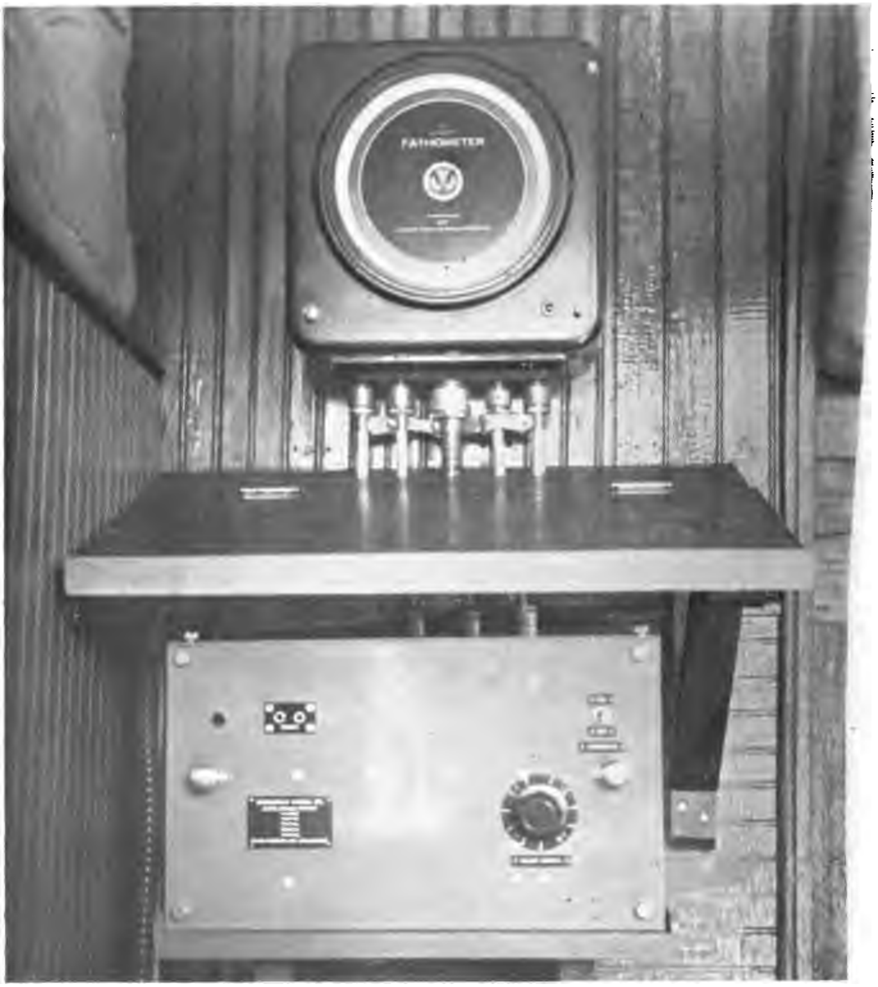


FIGURE 60.

water units. However, the governors then in service were not only too erratic for precise sounding but the adjustment of the control

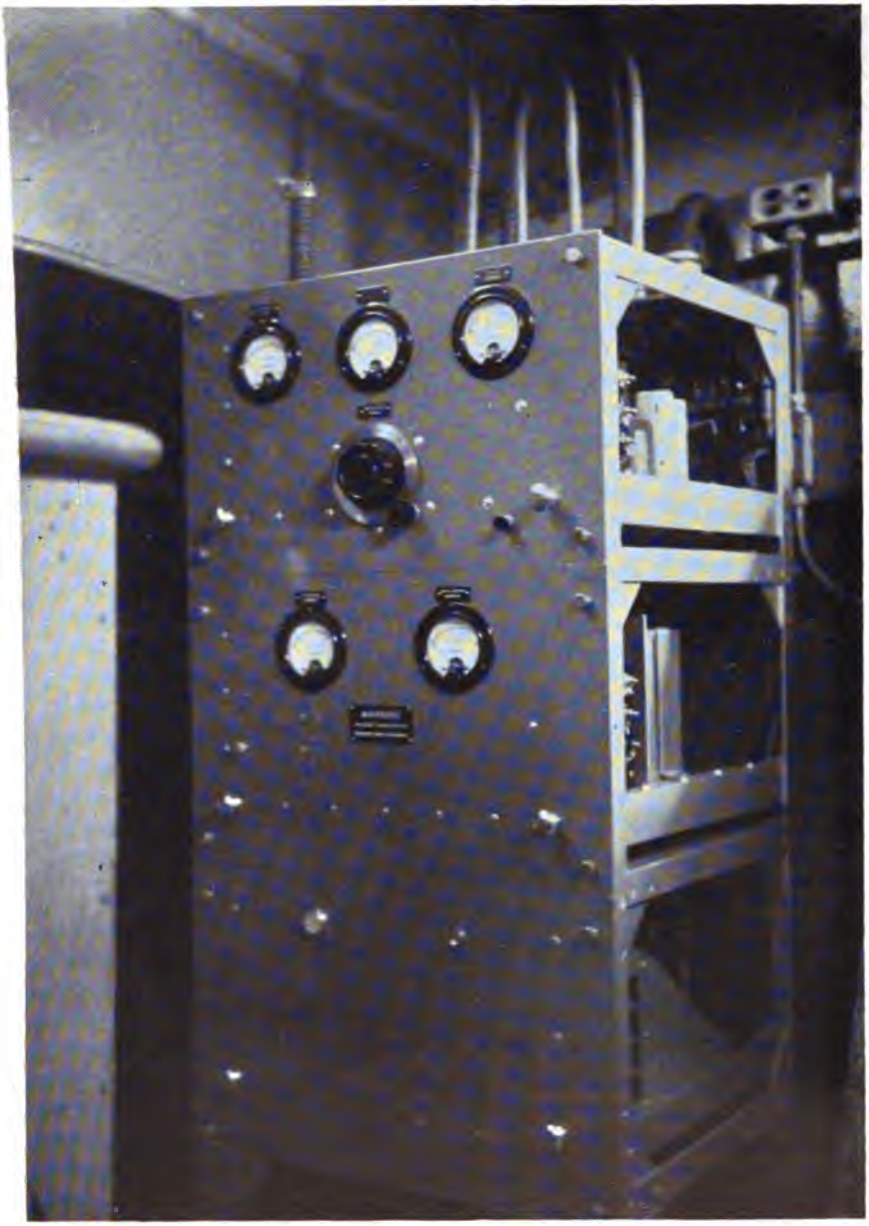


FIGURE 61.

point for temperature and salinity changes was so tedious that it was frequently considered less work to apply a mathematical correction before charting. Briefly, the problem became one of developing a motor governor which would be stable in performance and easy to adjust but rugged enough for work in the field and with a reasonable span of active life. Such a statement of objectives is one step toward attaining them but hardly more than that.

In the beginning it was recognized that the application of governing was of such a special nature that a revision of the conventional ideas on the subject was in order. We are accustomed to thinking of a governor as a device for maintaining a constant *average* speed, whereas the shoal-water sounding application, with time intervals of the order of one-thousandth of a second, demands constant *instantaneous* speed. To maintain constant instantaneous speed requires a governor moving element having instantaneous response to change—i. e., no inertia—and that condition is a theoretical impossibility with a mechanical device. In such a dilemma electronics offers an attractive alternative if we again make concessions to bulk and simplicity. However, a slight compromise can be made to accuracy if in so doing we still fall upon the safe side of our eventual accuracy of depth measurement by a wide enough margin to permit small cumulative errors in other parts. With these considerations in mind, the developments, conceived in the Office of the Chief of Engineers, were made in collaboration with the manufacturer. The moving parts of the governor have small inertia, providing the desired speed of response, and a micrometer screw adjustment of the contact separation without the necessity of stopping the motor has eliminated the tedious cut-and-try settings which could not be tolerated. As a check upon any erratic operation a sensitive indicating tachometer has been provided.

Early in 1939 the first indicating echo sounder equipment which included the new governor and tachometer was installed upon a survey vessel in one of the Engineer Department districts.

The indicating unit of this equipment is shown in figure 62, and a comparison of this with the earlier commercial model illustrated in figure 50 designates it as a transition or "change-over" model. It was made in this form for the specific purpose of modernizing the indicators of the figure 50 type, with a minimum of interruption to active survey operations in the field.

With equipment of this type, when the desired motor speed is known from temperature and salinity calculations it may be easily attained by adjusting the governor until the tachometer indicates the calculated speed on its dial. Then the governor action will maintain that speed. With the bar-check technique the proper control speed is not known initially, but the governor is adjusted until the echo sounder reads correct depth according to the bar setting. When this point is attained the tachometer indicates correct speed and the governor maintains that speed.

As temperature and salinity errors are of the percentage variety—i. e., the numerical error increases with increasing depth—it is obvious that compensation applied in the office to field soundings becomes more laborious than a mere offset applied to soundings at all depths. Thus accurate compensation in the field does constitute a considerable saving in time, and it is well worth an appreciable expense to provide it.

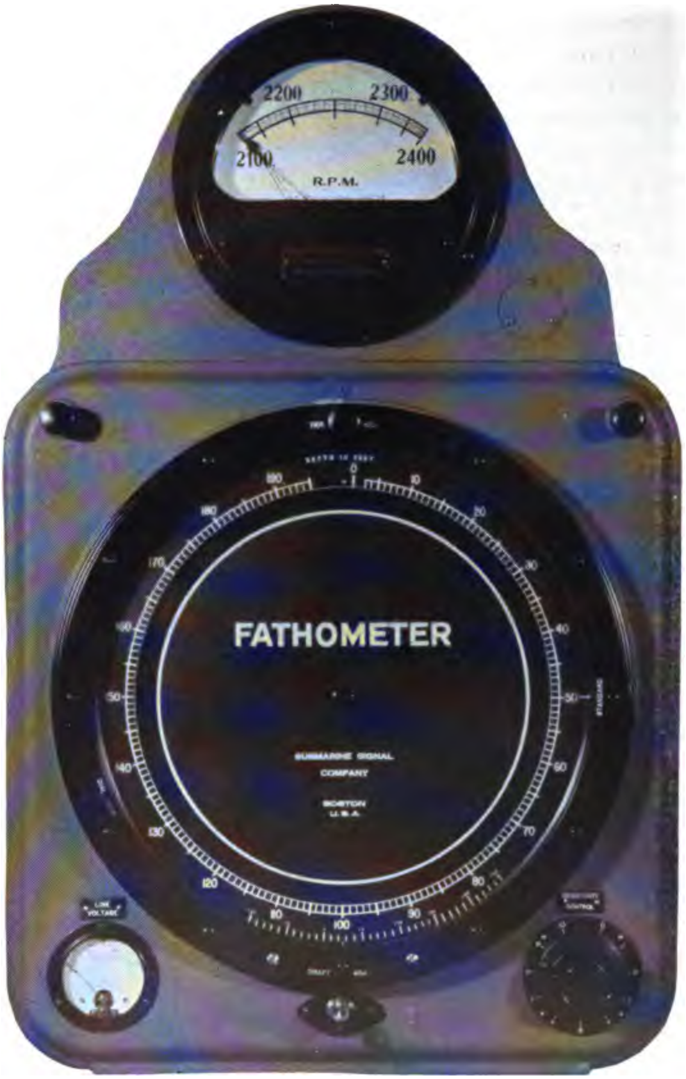


FIGURE 62.

Having attained this objective there still remained two more bugbears to contend with, and thought turned in the direction of ways and means to make on-the-spot compensation for water level (tide or river stage) and for draft plus squat of .the survey vessel. These variables are of the direct offset type, as they apply in the same magnitude to soundings at all depths; so to this extent they are much more amenable to control. Due to the character of these errors, it became relatively easy to compensate for them, although there is no evidence that such direct methods had ever been applied previously. The conception of the method came from the Office of the Chief of Engineers, and again its application was in collaboration with the manufacturer. Essentially it is the same as phasing, which has been previously explained, except that it is continuous instead of step by step. The process consists of moving the point of sound emission backward or forward the correct distance in scale units to correspond to draft, squat, and tide. In effect, this will move the whole scale bodily one way or the other. In so doing, the indication of sound emission (zero flash) will be lost if the scale shift is in that direction, but in the usual survey routine that has little or no significance. While the nature of tide and draft errors is such that numerical compensation in the office may not be so expensive, potential savings are still attractive, and in making the compensation in the field one more step is taken toward the goal of complete charting on the vessel during the progress of the survey.

As a result of the developments noted, the indicating unit illustrated in figure 63 was produced and installed on several survey craft. It includes the adjustable governor, the tachometer, and the compensating scales for draft, squat, and water level. The manual governor adjustment is in the upper right-hand corner of the front panel. The dial at the left below the large depth scale is a sequence switch with a step-to-step motion in one direction only. Its function is to start the various units of the equipment (gasoline-driven generator, indicator, etc.), in the proper order for best operation. Below the sequence switch is a key-operated switch for stopping and starting the entire equipment. The depth sounder was soon found to make such appeal to the curious that a locking switch was necessary. At the right center is a line voltmeter and below it is a dial for adjusting the gain of the electronic amplifier. Immediately below the depth dial is the indicating tachometer. The compensating scales are located near the inner periphery of the bezel around the depth dial. The draft-plus-squat scale, which for any given vessel is seldom changed after the initial setting, is set with a small lever below the bezel and then locked in position. The tide (water-level) adjustment is made by means of a knob at the top center of the bezel. This knob, operating through a rack and pinion, moves the depth scale bodily clockwise or counterclockwise past an index, and the gear reduction in the movement insures that the setting will not change due to vibration, so that no locking device need be provided.

Indicating depth sounders such as those shown in figures 62 and 63 are now in daily use in the hydrographic survey operations of the Engineer Department.

Shortly after the introduction of the tide and draft compensating scales an amusing incident occured to prove that despite our best-laid plans we are still quite human and hence fallible. The survey crew carefully set the compensation scales to read "depth to datum plane" and proceeded with the survey as planned. Performance was ideal and all elements clicked with clocklike regularity—including the tide. When the tide went out below datum the unfortunate party concluded a most successful survey day hard and fast on the mud flats—a compensatory grounding.

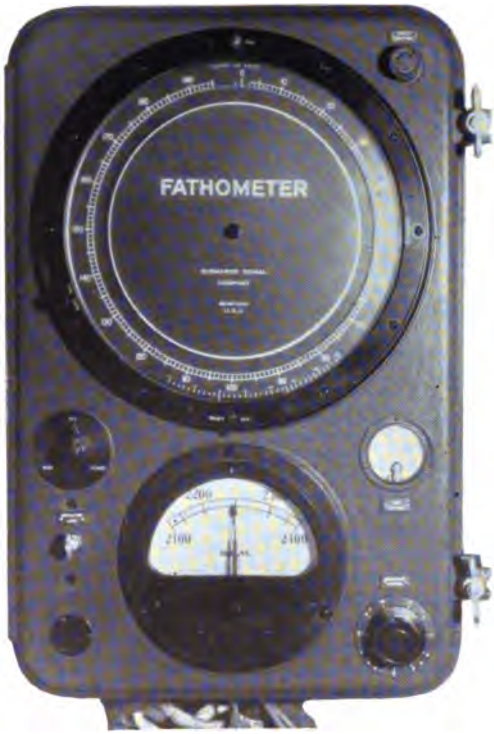


FIGURE 63.

As these indicating depth sounders gained wider acceptance it became evident that, in spite of the improvements effected, the idea of indicating depths had certain objectionable features which were inherent in the system. Of these objectionable features probably the most serious is the flashing-light index. Oddly enough, this flashing index is often considered to constitute an excellent selling point in favor of echo sounding indicators of that type, but in survey practice it is frequently a liability. In survey operations, watching the flashing index closely for an appreciable period invariably causes considerable eye fatigue, which of itself would not be so serious if the operator were aware of it. However, he seldom knows of the condition until many erroneous soundings have been listed, and then the survey course must be retraced with a new operator to observe the indicated depths. In this way the precision which has been so carefully built into the instrument may be entirely nullified by the human element, which is admittedly external but which in any indicating device is nonetheless an absolute necessity in the final result.

Another objection is the fact that the average trained operator can only record about 25 to 30 soundings per minute of the 720 that are flashed upon the scale. Again it is true that this is the human element, and as such it is quite beyond the indicating instrument to remedy, but insofar as end results are concerned it shows an efficiency of a very low order. Attempts were made to use an electric tape printing type of adding machine and the touch system to accelerate the listing of soundings, and while this was not a failure it has not been a notable success. All of these attempts led to the inevitable conclusion that the vulnerable spot in the chain lay in the human link and that any solution which would be satisfactory must eliminate that element. Automatic depth recording presented itself as the obvious means of accomplishing the desired results, and therefore early in 1939 a development program was initiated in the Office of the Chief of Engineers to design such a recorder. The commercial model of Henry Hughes & Son was well known, but some features of that recorder were not considered entirely satisfactory for the precise work of the Engineer Department and the compensation features were entirely lacking.

In June 1939 a Hughes precision echo sounding recorder (illustrated in fig. 55) was purchased and installed in a district survey vessel for observation and use in actual field survey service. This installation afforded an excellent opportunity to observe surveys where all soundings were recorded and to make comparisons of efficiency with those previously attained using indicating sounders. While it was frankly admitted that this equipment was not ideal for the purpose, it did serve well to crystallize thoughts and ideas as to what the ultimate requirements of our own design should be.

In the development and design of the new recorder the course was not a smooth one, as a host of parts, each with its own particular function, had to be integrated with the functions of many other parts to form a whole coordinated mechanism. The usual "growing pains" were experienced and at times the most unexpected and astonishing things happened, as they often do in work of this nature. However, in November 1939 a working model, embodying the features called for by the detailed recorder specifications of the Office of the Chief of Engineers, was finally completed, and a demonstration was held under the auspices of the manufacturer. In December this model equipment was shipped to the field for further demonstration under actual working conditions. The demonstrator model incorporated all the features which had been developed for the indicating units and a number of other features which field experience had shown to be necessary to more fully meet the survey requirements of the Engineer Department.

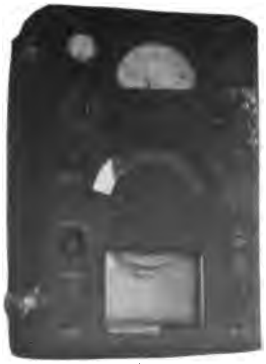


FIGURE 64.

A plan view of this demonstrator model is illustrated in figure 64. The case, hinged at the right side, is here shown closed and clamped in that position with swivel bolts and wing nuts. The functions of the various dials, control knobs, and meters will be explained. In order to obtain quiet operation and longer life the driver unit employs a gas-filled discharge tube in the condenser circuit which actuates the transmitting magnetostriction oscillator. As this tube operates on alternating current, it is advisable to operate all other units on alternating current also to avoid many other complications. The only difficulty involved in this is the accurate speed control of the alternating-current motor, and here it was found that the governor could be applied equally well to the direct-current motor of the motor-generator set. Although this necessitates remote speed control, the method worked well in practice. The micrometer screw adjustment of the governor contacts is operated by a small reversible motor attached to the motor-generator unit below deck. The action of the reversible motor is controlled by a drum type switch on the recorder panel so that easy speed adjustment is maintained. This switch has a spring return to the neutral point so that it cannot be left in an operating position. The speed-control switch is on the left-hand side of the panel just below the line voltmeter at the upper left corner.

A direct depth range of 3 feet to 75 feet is provided, and the range may be extended in steps or phases to a maximum of 205 feet. Phasing is accomplished by positioning a rotary switch located on the recorder panel near the upper left corner of the rectangular window. (See fig. 64.) In addition to the direct range the switch provides two other phasing steps and an "Off" position. The recorder is arranged with three keying contacts in the transmission circuit, each contact being connected to a point of the phasing switch. The contacts are set a definite number of angular degrees or scale feet apart, and in effect the switch simply moves the point of transmission (zero depth) back by the amount that the selected contact is offset from true zero. When the phasing switch is set at the "Off" position chart advance is stopped if for any reason continued operation of the mechanism is desired without using chart paper.

According to usual practice, draft and squat errors are taken as a summation and the net value compensated for. As this adjustment for any given vessel at usual survey speed seldom requires change, the case must be opened to set the compensator which is located behind the arc-shaped window in the front panel.

The adjustment for water level can be readily made from the front panel of the recorder and the scale position against the index may be observed through the arc-shaped window in the panel. The adjusting knob is located at the left-hand side of the panel near the left side of the arc window. This compensation is accomplished by an actual motion of the keying contacts through a relatively small range. The effect is much the same as phasing except that it takes place over a more restricted range and is a continuous process instead of being in steps. Through the medium of this adjustment it is possible to compensate for tidal variations as reported by radio or other communication with tide-gaging stations in the survey area. Thus when tide and draft have been compensated for, and when the motor speed has been made correct for the prevailing water temperature and salinity in the area, the recorded soundings will be correct to the desired datum and no computed corrections need be applied, except to such soundings as are so shoal as to be influenced by the error due to oscillator separation.

When sextant or transit sights (fixes) are taken to locate the position of the vessel, the operator at the recorder or the party chief on the survey bridge may push a button which will cause an arc line to be drawn clear across the depth record, thus coordinating the position with the recorded sounding at that point. A small selector switch on the recorder panel to the left of the rectangular window may be thrown to the "Local" position if the operator is to record the fixes or to the "Remote" position if recording from the survey bridge is desired. The push button for local use is on the recorder directly below the selector switch, and the button for use on the bridge is mounted at the end of a cord which may be plugged into a waterproof outlet there. This arrangement provides flexibility without chance of confusion if both buttons were in circuit. The system of speed control has been noted. The tachometer is located on the recorder panel in the center at the top and is directly connected to the alternating-current generator of the motor-generator set, as this generator and the recorder drive motor maintain a constant synchronous relation. A manually set hand, similar to those often used on aneroid barometers, has been added to the tachometer in order to more clearly indicate deviations from the desired speed.

At the top right-hand side of the panel is a rotary sequence starting switch which is designed to operate in one direction only. The function of this switch is to start the various units of the equipment (gasoline-driven generator, motor generator, recorder, etc.) in the proper order for best operation. Immediately below the sequence switch is the amplifier-gain control dial. This control enables the operator to maintain a clear and distinct depth record on the chart regardless of depth of water or absorptive bottom conditions which would tend to vary the sound echo strength. Passing from shoal depths over hard bottom to greater depths or soft bottom the echo may become considerably weaker and possibly fail to record a sounding. By increasing the amplification such conditions may be avoided. When the transition is in the other direction the echoes may be overamplified, resulting in stray or irrelevant sounds finding their way onto the chart record, so that the gain of the amplifier must be decreased. Briefly, the amplifier exercises a certain selective function which should be utilized. Below the gain control dial on the panel is a small pilot light which is normally inoperative. However, when only a few feet of unused chart paper remain upon the supply roll this pilot will glow as a warning.

Next in order below the chart pilot are (1) a key switch, (2) a chart light switch, and (3) a paper advance speed tell-tale.

The key switch is in the main line of the entire mechanism, and it therefore controls the operation of all of the equipment. The purpose of the lock and key is obvious. The chart-light switch is for the purpose of controlling two small lights placed inside the case to illuminate the chart record behind the window.

The paper advance speed tell-tale is simply a series of small light bulbs placed behind indicating targets to show at all times during operation the speed of paper advance then in use. Selective action as to these lights is incorporated in the paper advance mechanism. The speed of paper advance is variable in four steps by a pawl and ratchet system, which operates so that the chart is not in motion as the sounding is recorded.

Figure 65 shows the recorder with the case opened, and figure 66 shows the case opened and the hinged casting containing the moving mechanism swung out to expose the amplifier unit and other stationary parts. The design is such that parts are readily accessible for adjustment and repair. The case must be opened as in figure 66 to select the chart advance speed required. At the slow paper speed, and with soundings at a rate of about 200 per minute, adjacent soundings will merge, so that it is difficult to distinguish individual soundings. Such paper speeds are well adapted to surveys of the reconnaissance type where depth trends are of interest and where cost of chart paper may be a consideration. The fast speeds give excellent delineation of individual soundings, so that they conform well to the requirements of detailed surveys.

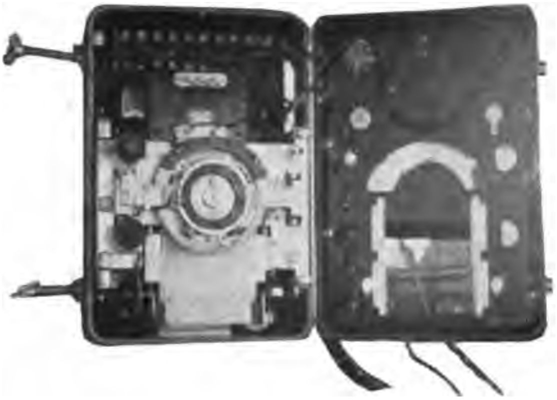


FIGURE 65.

It should be understood that there is no fixed relation between paper advance speed and speed of the survey vessel. Paper advance speed determines the separation between soundings on the chart but is no index of the distance between them on the bottom, as that is entirely a function of the forward speed of the vessel. As an example, a boat speed of 5 miles per hour with a sounding rate of 200 per minute places the soundings 2.2 feet apart on the bottom and a paper advance speed of 4 inches per minute would place those same soundings 0.02 inch apart on the record.

The stylus consists of a small length of tungsten or hard drawn steel wire mounted in a holder which somewhat resembles a chuck for small drills, so that new stylus wires may be easily inserted when the old ones require replacement. The stylus and holder are mounted upon a rotating disk, which has many dynamic advantages over the radial arm.

The chart paper marks a definite forward step in the art of high-speed recording, as the paper is perfectly dry at all times and the record may be considered a truly permanent one. This paper is one of several facsimile papers which have come into rather wide use recently for wire and radio transmission and reproduction of pictures and other matter of that nature. The graduations with numerical values, etc., can be printed in various colors as desired against a gray background, which is the color of the paper surface. The chart paper used thus far has graduation lines in red, which affords a good contrast to the gray background and the black depth record. The depth record is formed by a breaking down or oxidizing of the gray surface which exposes the black conducting under-surface layer of the paper. The depth trace is sharp and distinct against the lighter background, so that secondary echoes and other evidences of bottom characteristics reproduce with great fidelity. This paper is influenced in such small degree by climatic conditions that the overall accuracy of the equipment is in no sense endangered. Field notes may be made upon the chart with ordinary pen or pencil.

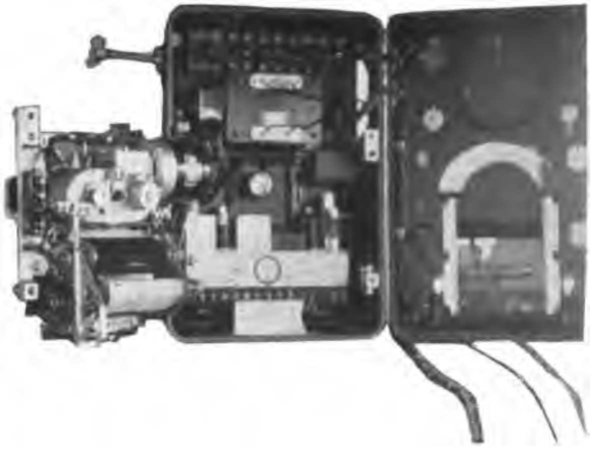


FIGURE 66.

During the course of the demonstrations in the lower Mississippi River the depth records showed many instances of variations from hard to soft bottom. Layers of collodial sludge, which at that season were quite near the river bottom, were clearly delineated; and, what was probably most remarkable, the records clearly showed both the depth of suspension and the thickness of layers of salt water in the river. These saline strata were well submerged in the vicinity of

New Orleans but gradually rose toward the surface, until at the Gulf of Mexico they merged at the surface with the sea. Density differentials between the river-water and the saline strata are the cause of the echoes in this case, but the detecting means must have great sensitivity to record echoes from strata having such small density differentials as existed. While such information is interesting and probably in some cases may have considerable value, the surveyor may not forget that it is but a byproduct and that the sounding is the main thing.

Production models of the recording echo sounder will be substantially as described except that a contacting clock will be included. The purpose of the clock is to make a mark on the edge of the chart for each minute and a distinctive mark for the hour. Timing circuits will also be included to actuate a buzzer 5 seconds before the minute and a bell at each minute as signals at the survey bridge for positioning sights. If sights were never missed due to poor visibility or other causes it might be well to have the bell contact also mark the fix arc on the chart, but until nature comes under better control the idea has been held in abeyance.

The recorder case is made of aluminum alloy with a nonreflecting finish. A slot is provided at the bottom through which the completed record may be passed if the automatic chart reroll inside the case is not used. Mounting lugs are provided on the back casting and the case is equipped with convenient outlets near the terminal board within.

The driver and motor-generator units are substantially housed and ready for mounting. The oscillators are generally designed for hull mounting either flush with the outer hull surface, as in figure 47, which is always done in the case of vessels with wood hulls, or in a liquid-filled tank within the hull, as is frequent practice with metallic hulls. Outboard oscillators, as shown in figure 48, can be used interchangeably with hull-mounted types if the nature of the work requires it.

The regular shipboard wiring regulations apply to all interconnecting leads except those carrying the high-frequency currents, which must be carefully shielded to avoid coupling, pick-up, and the like. The weight and physical dimensions of this equipment are not such as would make it adaptable to portable use in small boats such as skiffs and rowboats, but these applications were not considered in its design. An all-purpose recording echo sounder has many attractive possibilities as an ideal, but in practice the designer must make so many concessions that the final product is apt to be a mongrel—neither bird, beast, nor fish. In all probability, future demands of the Engineer Department will require a portable echo sounding recorder, for there are many applications where such an instrument would be ideal. As all of the essential elements are contained in the precision model, the design of the portable unit would not entail a great deal of development work, but sacrifices in the way of accuracy and compensation would have to be made. Such a project should be entered upon with a minimum of illusions.

It would be folly indeed to make any claims toward the development of the ideal precision recording echo sounder, for echo sounding is not a static art, and the chaotic state of affairs in our times has often given to the ideal device of today little but scrap value tomorrow. However, this new recording sounder, which was very largely conceived and developed through the efforts of the Office of the Chief of Engineers, is in several notable respects unique, and its advent marks a definite advance in the art of hydrographic surveying. The salient features of governing, facsimile recording, and compensation will do much to relieve the difficulties and tedium of the survey routine, and at the same time the entire survey process is immensely accelerated, with a considerable gain in precision.

A Typical Recorded Survey

For the benefit of those whose contact with the shoal-water survey work of the Engineer Department has not been recent, a brief outline of a typical day aboard a survey vessel will be of interest.

Figure 67 shows a typical survey-party organization where positions are determined by means of sextant angles, and tide conditions are received aboard the vessel at regular intervals by means of radio, using a portable transceiver at the gaging station. In the morning, on the way from the base to the survey area, the gasoline-driven generator will be started so that its output voltage will have time to reach a stable condition. Sextants are adjusted for index error, and the draft and squat compensation is checked and readjusted if necessary. Radio tuning and battery condition are inspected so that there will be no delay in starting operations. Range charts are placed in position and prepared for depth plotting. Upon arrival at the survey area the tide-gage readers are sent to their stations in small boats or set ashore by the survey vessel. Then a suitable and representative bar-checking location is selected, the check bar is unshipped, and checks at various depths made according to the technique previously outlined. By this means, or by water-temperature and salinity measurements, the drive-motor speed of the recording echo sounder is periodically adjusted to the correct point at the start of and at suitable intervals during the survey. The shore targets or survey buoys for the desired range have been selected by the chief of party and the survey then begins. The vessel proceeds along the range, and the draftsman, receiving the sextant angles from the observers on the bridge, immediately plots the positions on the range chart and keeps the helmsman advised as to deviations from the range. The echo sounder records depths at the rate of some 200 per minute as the vessel proceeds along the range at about 4 to 5 miles per hour. At intervals of 1 minute the warning buzzer is heard and 5 seconds later the fix bell. At the sound of the bell each observer reads and announces his sextant angle for the position, and the angles with their identifying fix number are entered in the field book. At the same time the chief of party on the survey bridge or the recorder operator will press the fix button to coordinate the fix with the depth, and the operator will mark the fix number in pencil at the end of the fix arc on the chart. He announces the depth at the time, and with data on depth and fix angles the draftsman will chart the depth and its location, using a suitable protractor. At the radio receiver the operator there will announce changes in tide data from the gage stations so that the recorder operator can set his tide compensation frequently to maintain all soundings with reference to datum. The recorder operator maintains a continuous check on motor speed by observing the coincidence of fixed and moving pointers on the tachometer and by means of the speed control switch makes such adjustments as may be necessary. He must also vary the amplifier gain occasion-

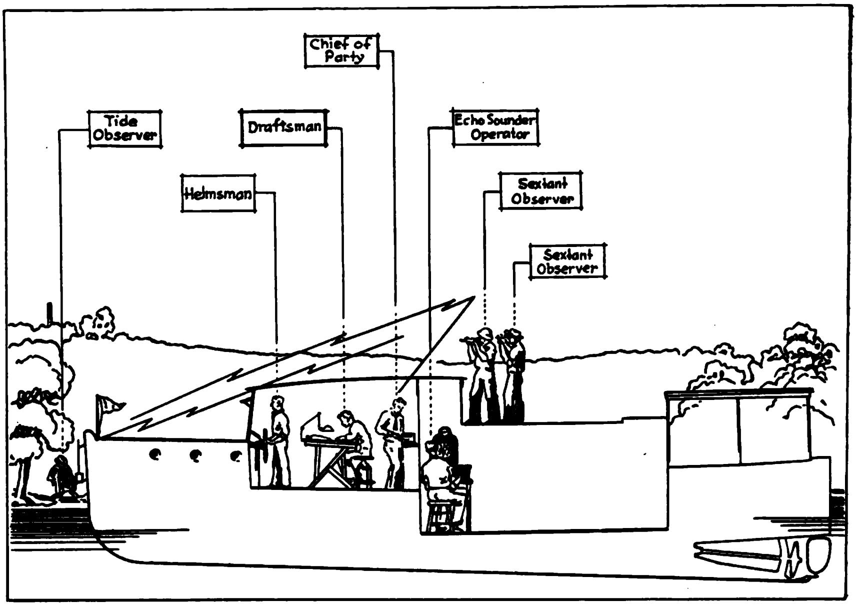


FIGURE 67.

ally if large variations in depth or bottom conditions prevail in the area. As depths pass beyond the range for which the phasing switch is set he must be prepared to rephase the recorder quickly so that the recording will be continuous. Bar checks are taken periodically during a survey to insure that temperature and salinity conditions have not changed appreciably and to compensate if they have changed.

The routine as set down on paper seems more involved than it actually is in practice, because each man has but few functions to perform. Where party organization and a survey technique such as outlined here have been adopted it is not unusual to cover from 18 to 35 statute miles per day and at the end of the day to have the entire day's work charted. The field book and sounding record may be turned in with the chart and intermediate shoals inserted before tracing.

The procedure as it stands represents a large saving in time and money to the Engineer Department, in one instance estimated at several times the installed cost of the equipment for 10 months of operation. Such a saving includes time and personnel not only in the actual survey operations but also subsequent economies which have been possible in computing and drafting. When such economies are effected, and at the same time greater accuracy is attained, so that charts and yardage estimates are more reliable, then there is cause for satisfaction.

CONCLUSION

In retrospect it becomes obvious that the great advances in the art of sounding, in common with those of other sciences, were seldom accomplished until the need for them became acute. The laying of the great transoceanic cables aroused universal interest in the conformation and character of the ocean bed, and therefore provided an immense impetus to sounding the ocean depths. Witness the work of Ericcson, Maury, and later Lord Kelvin. Then the *Titanic* disaster and finally the World War again stimulated thought on the subject so that today we have advanced very far beyond the days of lead and line. While many of the stimuli have themselves been catastrophic, we may derive a modicum of satisfaction from the fact that some of the effects have been beneficial.

As in the historical aspects of the story the various stages in the development of sounding pass in review, they may well serve to focus attention upon the early work of Matthew F. Maury if only to show the genius of the man who in that early day envisioned many of the sounding methods which we of this day are prone to consider commonplace.

Quite in keeping with its progressive record in many other fields of activity, the history of the art of sounding shows abundant evidence of important contributions by the United States Engineer Department. Of these, probably the greatest single contribution is the wire drag or sweep of F. C. Shenehon, which has gone far too long uncredited and unheralded. An active and alert interest in modern sounding methods permeates the Engineer Department today, as is evidenced by the developments of the few years past, and no doubt the future holds much of promise.

In following the account of recent developments the reader has no doubt realized that while the sounding operation has been tremendously accelerated there is still a very weak link in the sounding procedure. This link is found in the method of positioning, which is far out of step with the sounding tempo. Until the two are much more nearly of the same pace we shall continue to do somewhat of a limping and inefficient job. At a boat speed of 5 miles per hour we take position once per minute, i. e., every 440 feet, and in that distance we have some 200 soundings. To be sure this is not disastrous, but neither is it efficient. With full realization that this "bottleneck" exists, the Engineer Department is now engaged in the development of a fully automatic device to rapidly and continuously position the survey vessel and to plot that position on the chart as the vessel proceeds along the survey course. As the device is not based on visual principles, the vagaries of nature should only affect it insofar as they affect navigation. The perfection of this device in combination with the recording echo sounder will mark a further advance in hydrographic surveying.

BIBLIOGRAHPY

Out of a large mass of material available the following references are listed, with no thought of compiling a complete bibliography of sounding but merely a representative one for the reader. References are classified by authors when the author is known.

ADAMS, K. T.:

Echo Soundings. Field Engineers Bulletin, vol. 2, p. 46, published by U. S. Coast and Geodetic Survey.

Report on Echometer. Field Engineers Bulletin, vol. 4, p. 81, published by U. S. Coast and Geodetic Survey.

On Soundings. Hydrographic Review, vol. 16, pp. 59–65 (November 1939).

AMUNDSEN, R., and ELLSWORTH, L.: Our Polar Flight, p. 177.

BENCKER, H.: Echo Soundings. Hydrographic Review, vol. 2, No. 1, p. 54 (November 1924).

BERGMANN, LUDWIG: Ultrasonics and Their Scientific and Technical Applications. John Wiley & Sons, 1938.

BLAKE, R. F.: Submarine Signaling. Trans. Amer. Inst. Elec. Eng., vol. 33, pp. 1549–1565, (October 1914).

BORDEN, F. S.: The Dorsey Fathometer. Field Engineers Bulletin, vol. 10, p. 122; U. S. Coast and Geodetic Survey.

BOWMAN, D. W.: The Shallow Draft Fathometer. Proc. Louisiana Eng. Soc., vol. 23, No. 2, pp. 86–92 (April 1937).

BOYLE, R. W.:

Transmission of Sonic and Ultrasonic Waves Through Partitions. Nature (London), vol. 121, p. 55 (1928).

Ultrasonics. Science Progress, vol. 23, pp. 75–105 (1928).

BOYLE, R. W., and TAYLOR, G. B.: Constancy of Ultrasonic Velocity in Liquids With Increasing Frequency. Trans. Royal Soc. of Canada, vol. 21, sec. 3, pp. 79–83 (1927).

BOYLE, R. W., and REID, C. D.: Detection of Icebergs and Sounding With an Ultrasonic Beam. Trans. Royal Soc. of Canada, vol. 20, sec. 3, pp. 233–243 (1926).

BRAGG, W. H.: Listening Under Water. Engineering (London), June 13, 1919, pp. 776–779 (1919).

BULLARD, E. C.: Submarine Geology. Science Progress, vol. 34 (October 1939).

COLLINDER, P.: Methods of Echo Sounding and Principal Results to be Obtained. Hydrographic Review, vol. 11, No. 2, pp. 63–69 (1934).

COLMAN, J.: Sonic Soundings. Geographical Journal (London), October 1933, pp. 326–36.

CRANDALL, I. B.: The Theory of Vibrating Systems and Sound. Van Nostrand, 1926.

DORSEY, H. G.:

The Application of Physics to Modern Hydrographic Surveying. Denison, Univ. Bulletin, vol. 32, pp. 164–185 (August 1937).

The Dorsey Fathometer. Hydrographic Review, vol. 12, No. 2, p. 50 (1935).

Portable Depth Recorder. Field Engineers Bulletin, vol. 13, pp. 100–105, (1939); U. S. Coast and Geodetic Survey.

Dorsey, H. G., and Swainson, C. W.: Fathometer, White Light Method. Field Engineers Bulletin, vol. 4, p. 111; U. S. Coast and Geodetic Survey.

Dorsey, H. G.; Riddell, F. A.; and Tison, J. C.: Fathometer, Type 432. Field Engineers Bulletin, vol. 5, p. 50; U. S. Coast and Geodetic Survey.

Drysdale, C. V.: Modern Marine Problems in War and Peace. Journal Inst. Elec. Eng., vol. 58, pp. 572–597 (1920).

Edgell, J. A.: False Echoes in Deep Water. Hydrographic Review, vol. 12, No. 1, p. 19 (1935).

Engle, F. G.: Automatic Brake Sounding Machines. Field Engineers Bulletin, vol. 11, p. 61 (1937); U. S. Coast and Geodetic Survey.

Eve, A. S.: A Problem in Under-Water Acoustics. Journal of Franklin Institute, vol. 202, p. 627 (November 1926).

Eyeman, R. P.: Operation of Fathometer in Shoal Water. Field Engineers Bulletin, vol. 6, p. 55; U. S. Coast and Geodetic Survey.

Fessenden, R. A.: On Obtaining the Depths of the Sea by the Echo Method. Transactions American Inst. Elec. Eng., vol. 33, pp. 1569–1581 (October 1914).

Hart, M. D., and Smith, W. W.: The Principles of Sound Signaling. Van Nostrand, 1925.

Hawley, L. H.: Hydrographic Manual, Special Publication No. 143 (1935), U. S. Coast and Geodetic Survey.

Hayes, H. C.:

The Application of Acoustics to Submarine Surveying. Geographical Review (N. Y.), vol. 14, pp. 681–693 (October 1924).

Ocean Depth by Acoustic Methods: Journal Franklin Inst., vol. 197, p. 323 (1924).

Recent Developments in Acoustical Depth-Finding Apparatus. Hydrographic Review, vol. 4, No. 2, p. 205 (1927).

Measuring the Depth by Acoustic Methods. Hydrographic Review, vol. 2, p. 93 (1924).

Sonic Depth Sounder. Marine Review, October 1922, pp. 411–414.

The Behm Echo Depth Finder. Nautical Magazine, January 1925, pp. 53–59.

The Sonic Depth Finder. Proc. Amer. Philosophical Soc., vol. 63, pp. 134–151.

Hayes, H. V.: Submarine Signaling. Engineer, vol. 129, pp. 491–493, May 14, 1920.

Heck and Service: Velocity of Sound in Sea Water. Spec. Pub. No. 190, U. S. Coast and Geodetic Survey.

Hoskinson, A. J.; Shalowitz. A. L.; Burmister, C.: Echo Soundings, Slope Corrections. Field Engineers Bulletin, vol. 1, p. 18, U. S. Coast and Geodetic Survey.

Hughes, A. J.: Finding the Depth: The Nautical Magazine (Glasgow), Feb. 1927, pp. 127–130.

Hughes, Francis: How the Wreck of the Lusitania Was Found. The Nautical Magazine (Glasgow), January 1936, p. 33.

Hunt, Lt. E. B.: A New Sounding Apparatus. Silliman's American Journal, vol. 26, pp. 242–245 (1858).

Hutchings, Capt. J. F.: Echo Sounding Equipment for Ships. Trans. Inst. of Engineers and Shipbuilders in Scotland (1936).

Hydrographic Review: Nearly all numbers from May 1923 to the present contain interesting material on echo sounding.

Kellar, John G.: Hydrographic and Geodetic Surveying Manual for Use of U. S. Naval Surveys. Publication No. 215 of U. S. Hydrographic Office (1937).

Kelvin, Lord: On Deep Sea Sounding by Pianoforte Wire. Popular Lectures and Addresses, vol. 3, p. 337.

Kuwahara, S.: Velocity of Sound in Sea Water and Calculation of the Velocity for Use in Sonic Soundings. Hydrographic Review, vol. 16, No. 2, pp. 123–140 (1939).

Kuyama, T.: Magnetostrictive Underwater Sound Receivers. Science Abstracts, vol. 40, p. 2744 (1937).

Lambert, W. D.: The Physical Laws Underlying the Scale of a Sounding Tube. Special Pub. No. 61, U. S. Coast and Geodetic Survey.

Lamson, H. W.: The Use of Sound in Navigation. Journal Amer. Acoustical Soc., vol. 1, pp. 403–409 (1930).

Langevin, M. P.:

Le Sondage par le son (Sounding by Echo). Hydrographic Review, vol. 2, No. 2, pp. 51–121 (1924).

Ultra Sonic Sounding Machine. Spec. Pub. Intern. Hydro. Bureau No. 14 (1926).

On the Ultra Sonic Mirage. Hydrographic Review, vol. 8, No. 1, p. 140 (1931).

Libby, H. E.: A Graphic Pressure Recorder. The Military Engineer, vol. 23, No. 131, pp. 456–457 (1931).

MacMillan, D. H.:

Precision Echo Sounding and Surveying. Published by Henry Hughes & Son, Ltd., (London).

Echo Sounding in Harbor Hydrography. The Dock and Harbor Authority, pp. 296–300 (August 1938).

Maher, T. J.: Fathometer, a Check on Soundings. Field Engineers Bulletin, vol. 4, p. 85; U. S. Coast and Geodetic Survey.

Marmer, H. A.: The Sea.

Marti, P.: Notes on Acoustic Sounding. Hydrographic Review, vol. 8, No. 1, p. 124 (1931).

Mathisson, J. C.: Serial Temperatures by Bathythermograph. Field Engineers Bulletin, vol. 13, pp. 108–113 (1939); U. S. Coast and Geodetic Survey.

Maury, M. F.: The Physical Geography of the Sea. Published by Harper (1855).

McLennan, J. C.: Science and Its Application to Marine Problems. Engineering (London), p. 128 (July 25, 1919).

Meigs, M.: An Autographic Sounding Machine. The Military Engineer, vol. 14, No. 76 (1922).

Millington, E. C.: Science for Sailors, pp. 193–197, Published by J. B. Lippincott (Philadelphia), 1935.

Nicholson: Rochelle Salt as a Transmitter and Receiver. Proc. Amer. Inst. of Elec. Eng., vol. 38, p. 1315 (1919).

Pierce, G. W.: Magnetostriction Oscillators. Proc. Amer. Acad., vol. 63, pp. 1–47 (1928).

Pullen, Captain: An Account of Deep Sea Sounding. Philosophical Mag., 4th series, vol. 16, p. 458 (1858).

Ridge, W.: Practical Echo Sounding. The Gulf of Bothnia Sounded. Nautical Magazine (London), December 1930, pp. 515–517.

Rude, G. T.:

New Methods of Marine Surveying. Proc. Amer. Philos. Soc., vol. 79, No. 1 (1938).

The Dorsey Fathometer: Hydrographic Review, vol. 14, No. 2, p. 65 (1937).

Rude, G. T., and Adams, K. T.: Echo Sounding, the Graphic Recorder. Field Engineers Bulletin, vol. 6, p. 57; U. S. Coast and Geodetic Survey.

Service, J. H.: The Dorsey Fathometer. Jour. Franklin Inst., December 1928.

SERVICE, J. H.: Velocity of Sound in Sea Water. Field Engineers Bull., vol. 1, p. 32; U. S. Coast and Geodetic Survey.

SHENEHON, F. C.:

Static Method of Sounding. Annual Report, Chief of Engineers, U. S. Army (1900), part 8, p. 5326.

Sweep Method of Sounding. Annual Report, Chief of Engineers, U. S. Army (1903), vol. 12, part 4, p. 2763.

SIEMENS, C. W.: Determining the Depth of Sea Without Use of a Sounding Line. Trans. Royal Soc. (London), vol. 166 (1876).

SIGSBEE, C. D.: Deep Sea Sounding and Dredging. U. S. Government Printing Office (1880).

SINDING: The Behm Echolot. Hydrographic Review, vol. 2, No. 2 (1924).

SMITH, P. A.: Some Reflections on Echo Sounding. Field Engineers Bulletin, vol. 13, pp. 59–70 (1939); U. S. Coast and Geodetic Survey.

SWAINSON, C. W.: Sound in Water, Theory of Propagation. Field Engineers Bulletin, vol. 1, p. 26, U. S. Coast and Geodetic Survey.

TSCHERNING, H.: The New Ultra Sonic Sounders and Their Use in Hydrography. Hydrographic Review, vol. 10, No. 2, p. 166, 1933.

TROWBRIDGE, W. P.: On Deep Sea Sounding. Sillimans Amer. Jour., November 1858, p. 157.

WHIBLEY, CHARLES: Tudor Translation of Herodotus. Book 2, Part 1. Published by Alfred Knopf.

WOOD, A. B.: A Textbook of Sound. The MacMillan Co. (N. Y.)

WOOD, A. B., SMITH, F. D., and MCGEACHY, J. A.: A Magnetostriction Echo Depth Recorder. Hydrographic Review, vol. 13, No. 2, pp. 87–106 (1936); also Jour. Inst. Elec. Eng. Vol. 76, No. 461 (London), May 1935.

WOOD, R. W.: Supersonics. Published by Brown Univ. Press (1939).

ENGINEERING (LONDON):

Samuel James and His Submarine Kite. Vol. 51, p. 764, June 26, 1891.

Arnoldi Shallow Water Sounding Machine. Vol. 52, p. 699, Dec. 11, 1891.

The Behm Depth Sounder. Vol. 210, p. 595, Nov. 6, 1925.

Admiralty Type Recording Echo Sounding Apparatus. Vol. 131, pp. 726–729, June 5, 1931.

Marconi Echometer. Vol. 132, pp. 405–406, Sept. 25, 1931.

Hughes Magnetostriction Apparatus. Vol. 135, p. 96, Jan. 27, 1933.

Hughes Indicating Depth Sounder. Vol. 137, p. 117, Feb. 4, 1934.

Hughes Shoal Water Depth Recorder. Vol. 141, p. 160, Feb. 7, 1936.

Double Sounding Wheel as Used on Mississippi River. Vol. 143, p. 340, Mar. 26, 1937.

Marconi Echo Sounder. Vol. 144, Sept. 24, 1937.

UG
1
U58

STRATEGIC DEMOLITIONS OF RAILROADS IN FRONT OF THE GERMAN RIGHT WING

AUGUST-SEPTEMBER 1914

NUMBER 72, OCCASIONAL PAPERS
THE ENGINEER SCHOOL, UNITED STATES ARMY
MARCH 1940

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ENGINEERS
U. S. ARMY

STRATEGIC DEMOLITIONS OF RAILROADS IN FRONT OF THE GERMAN RIGHT WING

AUGUST-SEPTEMBER 1914

NUMBER 72, OCCASIONAL PAPERS
THE ENGINEER SCHOOL, UNITED STATES ARMY
MARCH 1940

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON: 1940

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, March 23, 1940.

Approved for publication:

J. L. SCHLEY,
Major General,
Chief of Engineers.

DEPOSITED BY THE
UNITED STATES OF AMERICA

SEP 19 '40

UG
1
.U58

STRATEGIC DEMOLITIONS OF RAILROADS IN FRONT OF THE GERMAN RIGHT WING, AUGUST-SEPTEMBER 1914

By Maj. DANIEL NOCE, *Corps of Engineers, United States Army*

I. *Introduction.*—Europe, the battleground of ages past, has once more assumed the spotlight on the world's stage with war playing the leading role—the might of France and England pitted against Nazi Germany. The opposing forces have manned their lines, but at this writing neither side has given a positive indication of where its main thrust will be. It is interesting at this time to review the initial operations on the western front in 1914 and in this connection, as engineers, to pay particular attention to the engineer operations there.

It is not the writer's intention in this article to present a treatise of the entire subject. Rather, one phase has been chosen—Strategic Demolition of Railroads in Front of the German Right Wing, August–September 1914, with a view of determining the actual accomplishments of the Allies, the effect of their demolitions on the German advance and battle efficiency, and the probable effect on the German right wing, had the demolitions been more complete. This one phase should be of more than casual interest, both because of its historical value to the military man and because of its timely military value in light of current happenings in Europe.

II. *General explanation of terms used in paper.*—In opening this study it is well to define certain terms used, thus insuring the clearer understanding of the author's intent.

By the term "strategic demolitions" is meant those demolitions which did interfere or, if used, might have interfered with the rapid advance of the German armies, from the time those forces crossed the frontier up to and including the Battles of the Marne and Aisne some 43 days later; included also in this term, "strategic demolitions," are such demolitions as did materially reduce, or if employed, might have materially reduced the battle efficiency of those armies during the above-mentioned period.

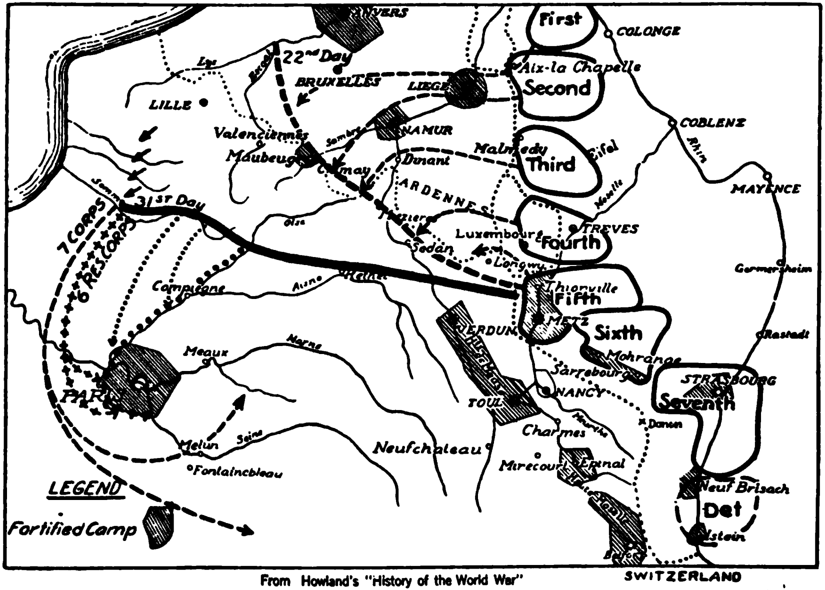
The phrase "right wing" as employed in the title of this study, is intended to confine the subject to the zone of advance, generally, of the First and Second German Armies; however, due to the very intricate railroad net, the scope of this report is in some cases broadened, to touch the zone of activity of the Third Army.

III. *War plans—German and Allies.*—Considered by themselves, demolitions are mainly of technical interest; but when considered in their relation to military plans they also become of definite military interest. Consequently, in order to be fully understood, strategic demolitions must likewise be regarded in connection with the strategic plans of operations of the forces concerned.

It is therefore desirable, at this time, to present briefly the plans of operation of the opposing nations as they existed at the outbreak of the war.

The German plan of 1914 (see pl. No. 1) provided for concentrating the bulk of its forces, that is, the First to Fifth Armies, inclusive, in the general area extending from Aix-la-Chapelle south to Metz. Then, during the advance, the greater part of the troops would pass north of the strongly fortified eastern frontier of France and through Luxemburg and Belgium. Thus there would be a wheel to the southwest pivoting on the Metz area. The rate of progress in this movement was to be governed by the right wing (the First and Second Armies), whose mission was to advance through Belgium north of the Meuse, defeat the French, forcing them back on Paris, and then by wheeling the German extreme right wing around Paris against the left flank of the French Army, win a decisive victory (*1*) [1]

THE GERMAN PLAN 1914
WESTERN THEATRE OF OPERATIONS



From Howland's "History of the World War"

PLATE 1.

At the outset of the campaign, a strategic advance guard was to move forward rapidly, take the Liege fortified area with the utmost speed, seize the bridges over the Meuse in that region, and open the routes of march, barred by the fortress, so that the First and Second Armies could begin their forward movement (*2*).

---

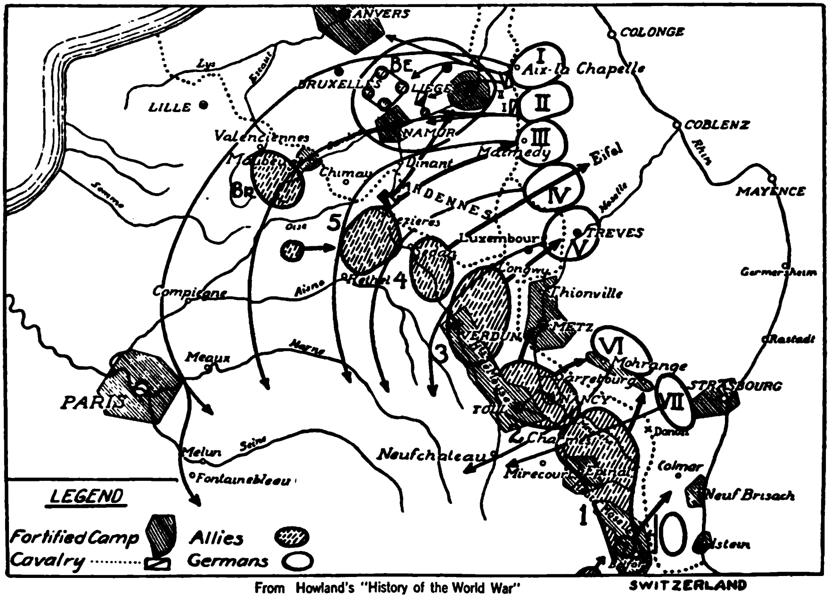
[1] The key to the system of footnotes used in this paper is as follows:
The first figure refers to the reference number in the body of the text itself; the second number to the number of the book found in the bibliography at the end of this article; and the third number or numbers indicate the pages in the book where the reference may be found. Thus the footnote (8) No. 12, p. 18 means the statement in this text numbered 8 may be found in book 12, i. e., Topography and Strategy in the War by Johnson, on p. 18.

(*1*) No. 1, pp. 85–88; No. 5, p. 10; No. 14, p. 30.
(*2*) No. 1, pp. 85–88; No. 14, p. 32.

The Belgian plan (see pl. No. 2), in case of attack by Germany, was to base her defense on Antwerp with the idea of covering Brussels. She planned to hold Liege and Namur as fortified camps and defend the interval between these camps with her field army. At the outbreak of the war Belgium placed part of her field forces in the Liege and Namur areas and concentrated the bulk in the area between Antwerp and Nemur (*3*).

The French plan (see pl. No. 2), was predicated on the theory that she would be attacked on the Franco-German frontier; that is, between Switzerland and Luxemburg. It provided for concentrating five armies in the interval, Belfort-Sedan, inclusive; of these, the fourth was to be held in reserve west of Toul-Verdun. It was believed that sufficient flank protection could be obtained by placing groups of reserve divisions in rear of each flank. However, the violation of the neutrality of Belgium necessitated moving the Fifth Army to its left and placing the Fourth Army in the interval between the Third and Fifth. Upon the advent of Great Britain on the side of France, its Army was placed on the extreme left. The original French plan contemplated her main operations on either side of Metz and in Alsace-Lorraine, but not in the north. Plate No. 2 shows the combined Allied and German plans (*4*). Plate No. 12 shows the zone of advance actually followed by the German right wing.

GERMAN AND ALLIED PLANS
WESTERN THEATRE OF OPERATIONS



From Howland's "History of the World War"

PLATE 2

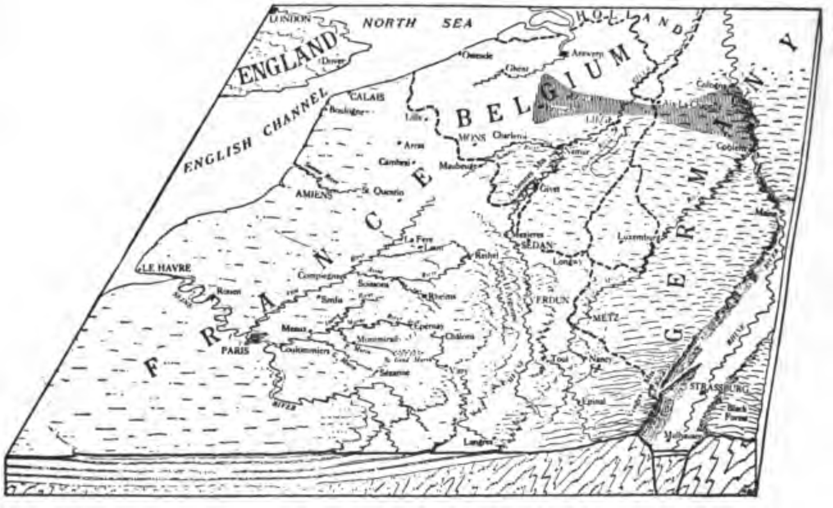
Initially, there was insufficient strength on the Allied left to check the German main effort. Subsequent events showed clearly the in-

---

(*3*) No. 14, p. 30; No. 6, p. 10.
(*4*) No. 14, pp. 31, 32; No. 7, p. 4.

adequacy of the forces, and it was necessary for Joffre to regroup his armies, concentrating a new army at Paris (*5*).

IV. *Topography with special reference to communication.*—A discussion of the topography is, in reality, a study by itself. A casual glance at plate No. 3 shows clearly the efficacy of and the reason behind Germany's decision to march through Belgium, rather than chance the more hazardous routes to the east. On the eastern border of France the Vosges Mountains, the mountains of western Germany, and the Ardennes of Belgium "constitute a broad outer barrier within which concentric belts of plateaus with east facing scarps defend the most direct approaches to Paris" (*6*). Through Belgium and northern France alone is there a pathway sufficiently free from obstacles, sufficiently wide and possessing the required facilities for the large scale movement of armies. And yet, this too had its drawback. For the entrance to this rich plain is controlled by the bottle-neck at Liege. Here the so-called Ardennes Mountains, in reality rugged uplands over which troop movement would be virtually impossible, extend north to the vicinity of Liege, while the great Lumberg Peninsula of Holland extends nearly south to Liege. Thus the portion of this plain in Belgium is narrowed to a neck of land only a few miles wide, through which the German divisions must pass to gain access to the rich plains of northern France. To complicate matters even more, the valley of the Meuse, bordered with fairly high banks and cut with a watercourse 100 yards and greater in width, sweeps across this relatively confined gateway. Guarding both the river approach and gateway stood the strong forts of Liege.



DIAGRAMMATIC VIEW OF THE WESTERN THEATER OF WAR
From Johnson's "Topography and Strategy in the War"

PLATE 3.

(*5*) No. 14, pp. 42, 43; No. 1, pt. VII.
(*6*) No. 2, pp. 26, 27; No. 12, pp. 16–25.

To the northeast of Liege and between it and Aix-la-Chapelle the plains of southeastern Belgium are cut with a complex system of medium sized streams and a rather intricate system of low, rolling hills. Above the valley bottoms the land is comparatively dry and contains a splendid network of railroads and highways. Naturally such a terrain required numerous bridges and tunnels, and, because of this, communications, due to the possibility of Belgian demolitions, were vulnerable.

To the west and south beyond the stricture at Liege, the natural highway of the Meuse Valley is joined by the Sambre. Following west along this valley only a low divide separates it from the Oise Valley and a direct route to Paris. Following this combined Meuse-Sambre-Oise Valley route is a through, double-track railway line from Berlin to Paris (*7*).

Along this proposed path for the German advance we find terrain slightly rolling and cut by numerous small and moderate size streams, but, nevertheless, a terrain presenting no military obstacles of first magnitude. Rather, its richness and gentle topography made it from the military viewpoint the ideal route for an advance on Paris; quoting Douglas Wilson Johnson's Topography and Strategy in the World War, it possesses four advantages, i. e. (*8*).

> 1. Interrupted by no topographic barrier of serious proportions.
> 2. Supplied with numerous parallel roads and railways by means of which to advance simultaneous columns of troops.
> 3. Productive enough to supply food for sustenance of large armies for long periods.
> 4. Passes close to important coal and iron deposits in the borders of Ardennes.

Still, this seemingly ideal country had two serious disadvantages, the extensive system of bridges and tunnels made communications vulnerable, due, to the probable chance of intensive demolitions by the Allies; and, secondly, access could be obtained only through the stricture at Liege.

V. *Demolition of railroads* (*Allies*).—Prior to presenting the activities of the Allies in relation to the demolition of railway lines, it is probably well to discuss briefly the important events immediately preceding the invasion and up to and including the arrival of the Germans at the Meuse.

The Belgian Army was ordered to mobilize at 4 p. m., July 31, 1914, (*9*); at 7 p. m., August 2, Germany handed her ultimatum to Belgium, demanding free passage through that country (*10*); early on August 4 the first of the German troops crossed the frontier, and thus violated the neutrality of Belgium (*11*); late the same day the advance elements of the German divisions reached the Meuse at Vise (*12*); and the following day they appeared in considerable numbers before the forts of Liege (*13*). Once more the diplomats of the world had failed, and Germany launched forth on her mighty adventure in arms that was destined soon to involve the world in 4 years of bloody turmoil.

(*7*) No. 4, pp. 2, 3; No. 2, p. 28.
(*8*) No. 12, p. 18.
(*9*) No. 11, p. 25.
(*10*) No. 4, p. 2; No. 9, p. 9.
(*11*) No. 9, p. 15; No. 14, p. 32.
(*12*) No. 14, p. 32.
(*13*) No. 8, p. 35; No. 14, p. 32.

It may be well at this time to observe that the great strategic value of the main line railways in the prospective theater of operations was understood only too well by the commanders of the Allied and German forces. This fact is significantly illustrated by the statement of the Kaiser in his ultimatum to Belgium on August 2, 1914, in which he said, in part:

> **If Belgium acts in a hostile way against German troops and specially makes difficult our forward march by destroying roads, railroads, canals, and other constructions, Germany will be obliged to consider Belgium as an enemy (*14*).**

A. RAILWAY DEMOLITION PLANS—ALLIES

Specific plans for demolition of the strategic railways in the event of war had been made long before 1914 by both Belgium and France. The former country had, prior to the onset of the war, built mine chambers into most of the important bridges and had prepared plans providing for their destruction in the event of war. Belgian regulations, dated as early as February 14, 1914 (*15*), apparently provided for these demolitions in two categories:

1. Those big destructions prepared before and during mobilization.
2. Demolitions during operations.

Each of these categories was further divided into three classes:

(*a*) Those needed for the general defense of the country.

(*b*) Those necessary for the defense of the Liege fortified area.

(*c*) Those necessary for the defense of the Namur fortified area.

However, it is interesting to note in connection with these plans that in the Liege area no provision was made to place charges in the bridges prior to actual mobilization. Thus, the Belgians had some 96 hours to place the necessary charges and to destroy the bridges on their frontier.

The French plan differed somewhat. The regulations in force in 1914 divided structures suitable for demolition into two classes (*16*).

First, those which concerned the operations in general: Their demolition was prepared, the mine chambers built in, the supply of explosives, together with means of transportation, provided for, and the personnel appointed.

Second, those which concerned only a part of the operations or the defense of the forts: In the zone of operations, the commander in chief (with authority to delegate his power in certain cases) could give the order to destroy any first-class construction or any railroad structure. Army commanders or governors of forts could order the demolition of any second-class structure, but they could not delegate this power to others (*17*).

B. LOCATION OF IMPORTANT RAILROADS

Plate No. 4 shows the strategic railroads in the theater of operations. A glance at this map will show the observer the critical section in this net. While there existed complete systems of railroads within France, Germany, and Belgium, the frontiers themselves were strongly disquieting to an army that depended upon

---

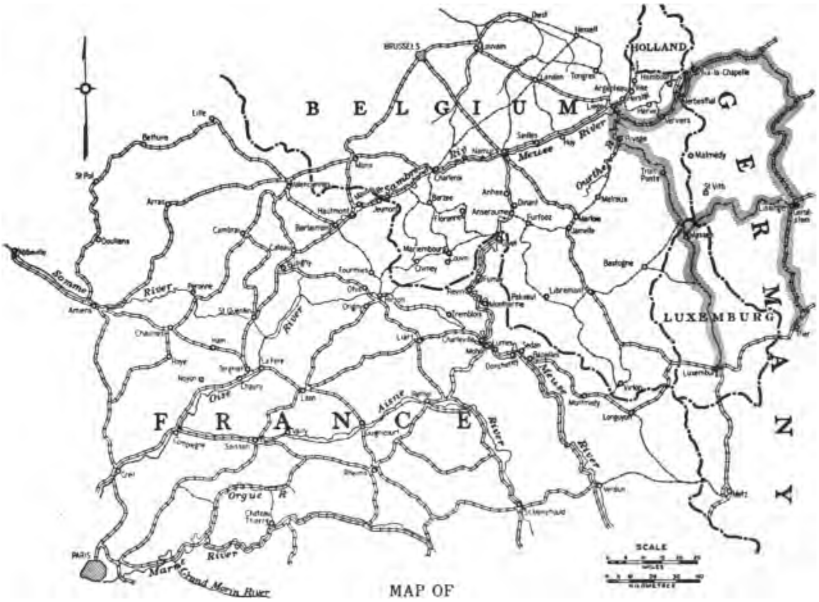
(*14*) No. 10, pp. 16–19; No. 11, pp. 29, 32.
(*15*) No. 4, p. 2.
(*16*) No. 4, p. 3; No. 3, pp. 27, 28.
(*17*) No. 4, p. 3.

railroads for its very existence. For connecting the lateral Aix-la-Chapelle–Trier and the lateral Liege–Luxemburg, there were but two railway lines in the zone of the right wing:

1. A double-track main line from Aix-la-Chapelle to Liege (paralleled part way by a single track line through Herve).
2. A single track line from Lissingen to Massen, through St. Vith.

South of the latter line was the double-track railway from Trier to Luxemburg. Thus, we see that once again Liege holds the key to the situation—it completely dominates the railroads to the north.

On the line from Aix-la-Chapelle to Liege, some 26 miles in length, were 20 tunnels, 1 viaduct, and 15 bridges; on the line through Herve, 1 bridge; and the Trois-Ponts line had 4 tunnels and 11 bridges. At Liege, the lines converged and crossed the Meuse on a rather long bridge (*18*). From Liege west toward Brussels, the slopes of the valley of the Meuse are comparatively steep, and special engines are required to pull the main-line trains up this incline. At several points along the valley side, the main line was pierced by highway underpasses, and because of these structures the line was considered quite vulnerable (*19*).



MAP OF
NORTHERN FRANCE AND BELGIUM
STRATEGIC RAILWAYS

PLATE 4.

C. DEMOLITION OF RAILROADS—BELGIAN

In command of the Liege fortified area (generally the area between Huy and the Holland Border) was General Leman. Although

---

(*18*) No. 4, p. 3.
(*19*) No. 2, p. 28.

definite demolition plans existed, it is probable that the surprise action of the German high command in violating the neutrality of Belgium, and the rapidity of their advance, resulted in confusion and misunderstanding in the minds of the Belgian leaders relative to the proper execution of their plans. Be that as it may, the demolitions as employed in the vicinity of Liege can, at best, be considered but a feeble attempt at a most important job. For the greater part, the destruction was confined to blowing up of what, for lack of a better term, may be called railroad accessories; signal blocks, telephone and telegraph systems, and water towers. A few tunnels were barricaded or blocked by crashing locomotives and cars within them, and in some cases sections of rail were cut with explosives. Three tunnels at Trois-Points, Hombourg and Melreux, and one bridge over the Ourthe were thoroughly destroyed. However, only a small fraction of the railroad structures were demolished, and the Germans were presented with the most important "Pont du Val Benoit" bridge over the Meuse which carried the main line from Aix-la-Chapelle and the branch line from Herve (*20*).

During the retreat to Antwerp, the Belgians made no demolitions of importance in the double-track line, Liege-Brussels-Mons (*21*).

In the fortified area of Namur, probably because of superior coordination, a more thorough understanding of the importance of demolitions and slightly greater available time (not till August 19 did the Second Army in strength reach the Namur forts), a much more commendable job of military demolitions was accomplished. During the period of mobilization, bridges, and tunnel sites were prepared for destruction. The rapidity of these preparations is well illustrated by the fact that on August 3, only 5 days after the forts had been cleared for action, practically all demolition preparations were complete. The following day the commander, General Michel, received instructions to destroy the rail centers at Marloie, Libremont and the tunnel at Furfooz (see pl. No. 4). The previous preparations made it possible for the engineers to complete the total destruction of these structures with splendid efficiency upon receipt of notice that Germans had violated the frontier, and, by this work, cut the important lateral, Luxemburg-Namur, in four places and the side lines in several locations (*22*).

Further destruction of railway structures in this area was carried on in a systematic and thorough way. Outstanding was the complete reduction of the two railroad bridges over the Meuse at Namur (August 23) (one, the double track, Luxemburg-Namur; the other, the single track, Dinant-Namur line), and the Seilles tunnel (August 19). By this work all lines entering Namur from the east were out. It is to be noted, however, that not all bridges and tunnels were destroyed in the area indicated; only those considered strategically most important were cut (*23*).

D. DEMOLITION OF RAILROADS—FRENCH

Two major railroad systems lay along the zone of the German right wing in French territory (see pl. No. 4); the "Nord" system,

---

(*20*) No. 3, p. 316; No. 1, p. 61; No. 2, p. 28.
(*21*) No. 3, p. 316; No. 1, p. 1.
(*22*) No. 6, pp. 47, 48.
(*23*) No. 6, p. 48.

which lies generally within the area, Amiens-Lille-Maubeuge-Hirson-Soisson-Compiegne; and the "L'Est" system east of the above area. While each system had its place in the French plan, it is interesting to note that in conformity with plan XVII (which did not contemplate a wide swing on the north by the Germans), main structures on the "L'Est" railroad were placed in the first class for demolition, whereas on the Nord system, all structures were rated as second class (*24*).

It appears that, although definite plans for demolition of the Nord Railroad had been prepared by the French General Staff, little had been done prior to the beginning of hostilities to facilitate their coordination. At the outbreak of the war there was not a single unit of engineers at the disposal of the military commissioner of this system. So poor was the coordination that General Dumont, the commissioner, stated:

> Still worse, all data about the permanent preparations on the large constructions were sent to me on August 1, 1914: About 200 mimeographed pamphlets. * * * And, there was no time to study them carefully. After Charleroi, two companies of engineers sent to work on the Reseau were not able to get further than the line, Bethune-Arras-Amiens-Tergnier-Laon. They found the chambers prepared for the charge unloaded and practically all the supplies of explosives were gone. This was true for Arras and Amiens. All they could do was to demolish a number of small constructions on the Bethune-St. Pol-Doullens-Amiens Line and between Abbeville and Tergnier. The northern system was left open to the enemy up to Laon (*25*).

While the exact number of structures destroyed by the French cannot be ascertained, it is known, however, that after the German retreat the number of large structures blown by both the Germans and French on the Nord system totaled 56 with the majority, perhaps, accomplished by the French (*26*).

On the "L'Est" system conditions were considerably better though still far from ideal. Some regular companies of engineers were on hand to take the place of the local civil engineer service, which had apparently vanished at the time of evacuation. The Military Commissioner was granted considerable power, and, although he had insufficient instructions and information, he performed a very commendable bit of work in blowing loaded mines, while others were loaded with and destroyed by such explosives as could be found in local military depots (*27*).

Under the war plans, provisions were made for 139 demolitions on the L'Est system, of which 58 (structures of sufficient importance to be provided with mine chambers) were rated in the first class.

Actually, 32 demolitions were completed, and these may be classed in 3 groups as follows (*28*):

(1) Three around Charleville executed during concentration.

(2) Eighteen during the operations along the Meuse, executed between the 22d and 29th of August.

(3) Eleven during the French retreat between the 1st and 9th of September.

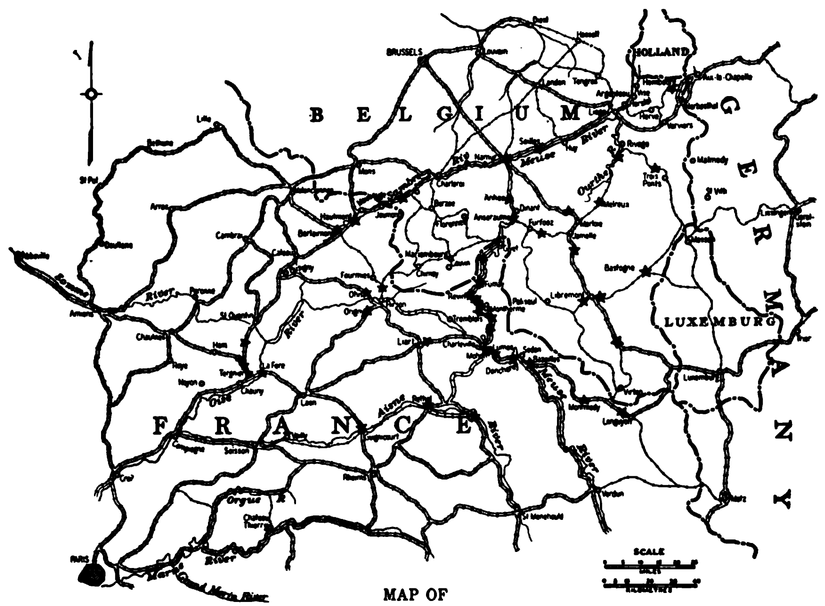
(*24*) No. 13, pp. 27, 28; No. 4, p. 4.
(*25*) No. 4, pp. 4, 5.
(*26*) No. 4, p. 5.
(*27*) No. 4, p. 5.
(*28*) No. 4, p. 3; No. 13, pp. 27–28.

Many structures of sufficient importance for destruction were left intact for a later offensive (*29*).

E. SUMMARY AND RESULTS OF RAILROAD DEMOLITIONS

As a summary of the foregoing, the following is a list of railroad structures that were demolished in Belgium and on the Nord and L'Est systems in France in the zone of the German right wing armies. This list was compiled from various references (*30*), but is by no means complete (see pl. No. 5).

Along the Belgian frontier, the tunnels at Hombourg, Trois-Ponts, and Melreux, and one bridge on the Ourthe, were thoroughly demolished. Of these, none, however, were railroads of first importance. Other demolitions in this area were unimportant.



MAP OF
NORTHERN FRANCE AND BELGIUM
LOCATIONS OF IMPORTANT DEMOLITIONS

PLATE 5.

In the Namur area, the tunnels at Seilles and Furfooz and the railroad bridge over the Meuse within Namur were carefully and completely demolished. There were also minor demolitions (character not known) in the railroad centers of Marloie and Libremont.

Along the Meuse, between Namur and Sedan, some 13 bridges were destroyed, according to one authority, or 40 "large railroad bridges," according to another (*31*). (The latter number is more probably correct.) Their locations, in general, were: Namur, Anhee, Anseraume, Fumay, Revin, Montherme, north and south of Charle-

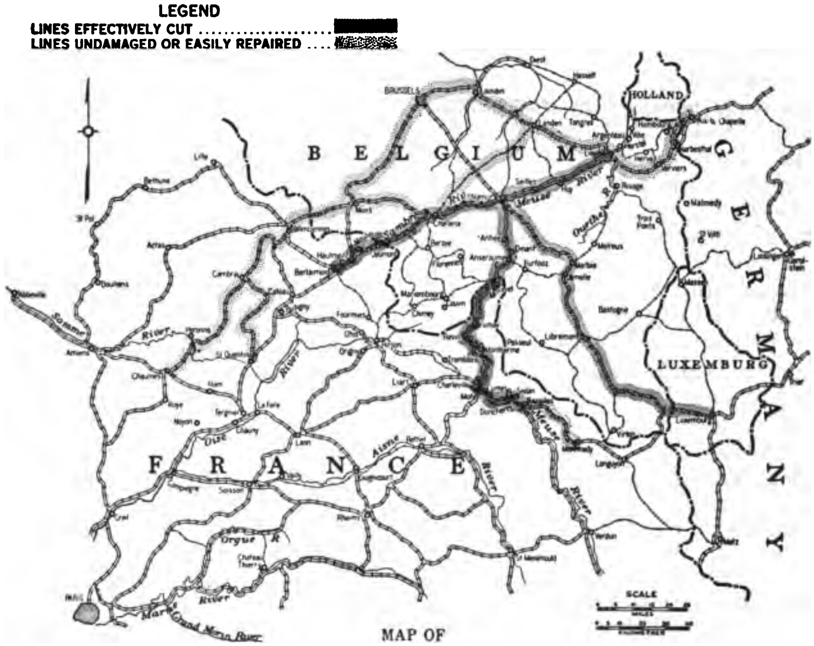
---

(*29*) No. 4, p. 15; No. 13, pp. 27–28.
(*30*) No. 4, pp. 3–5; No. 3, pp. 316–319; No. 13, pp. 27, 28, 66, 67; No. 2, pp. 28–33.
(*31*) No. 3, p. 316; No. 2, p. 30.

ville, Mohon, Lumes, Doncherey and Bazeilles. In addition, along this same line the tunnel between Mohon and Charleville was destroyed.

Between the Sambre and Meuse, practically all vital railroad structures were destroyed. Of particular importance was the destruction of the large viaducts around Hirson, at Fourmies, Ohis, and Origny; the tunnel at Liart; and the bridge near La Fere.

Over the Sambre the bridges at Jeumont, Hautmont (destroyed by Maubeuge fortress engineers) and Berlaimont, and those over the Aisne at Vailly, Rethel and Guignicourt were all blown. Farther out four large structures over the Oise and Crozat Canal in the stretches from Laon and St. Quentin to Tergnier were shot out.



MAP OF
NORTHERN FRANCE AND BELGIUM
RAILROAD SITUATION FACING THE GERMANS

PLATE 6.

Opposite the center of the German Army, along the main lines leading to Sedan and Charleville, the tunnels of Longuyon and Montmedy were so completely destroyed, that the construction of a detour was started at the same time that work of clearing the tunnel was begun.

By these allied demolitions the railroad situation that faced the Germans was as follows (see pl. 6):

1. A double track line, with minor demolition capable of being quickly and easily repaired, was literally presented to the Germans via Aix-la-Chapelle-Liege-Brussels-Mons-Valenciennes-Cambrai-St. Quentin.

2. The line Liege-Namur, thence west and south, was thoroughly blocked.

3. In the center of the German path, railroads leading west to Charleville and Sedan were effectively cut and likewise the line along the Meuse from Sedan to Namur.
4. The important lateral from Luxemburg to Namur was demolished at several points.

F. DISCUSSION

In any discussion relative to the apparent weakness of the demolitions of the Allies one must remember the German attack was swift, powerful, and splendidly planned. Naturally, the element of surprise was in their favor. Granting all that, it is the opinion of the writer that the Allies gave evidence of a critical weakness in the conception of and the execution of their demolitions as a whole. They displayed a remarkable lack of coordination in their efforts around Liege. Realizing the military importance of this fortress, it is difficult to understand why no concerted effort was made to destroy the important "Pont du Val Benoit" bridge over the Meuse, and the Liege-Brussels railroad line.

Likewise exhibiting a remarkable weakness in conception and execution was the work of the French in their demolitions on the Nord railway system.

A notable improvement in the use of demolitions can be noticed in the vicinity of Namur and on the L'Est Railroad System and, for this, due credit must be given. The work here, in general, was thorough and well executed. However, this could not repair the lack of demolitions at Liege, and on the Nord railway, and this lack, as I shall attempt to show later, was a material factor in aiding the rapid German advance on Paris.

VI. *The German situation.*—

A. GERMAN PLAN OF OPERATION TO COMBAT ALLIED DEMOLITIONS

To complete the picture presented above, we must now turn our attention to the German organization; the plans and adequacy of their means to reestablish necessary lines; and, finally, the adverse effect, if any, the demolitions had on their strategic plans.

The German High Command realized that the ultimate success or failure of its campaign was vitally linked with their ability to rapidly and satisfactorily reestablish the necessary lines of communication. It was also their belief, founded on the accepted principles of warfare, that the French and Belgian forces would do all in their power to destroy, beyond feasible repair, such lines of communication and supply as lay within their areas. In accordance with these beliefs, the Germans had made extensive plans for the repairing of any destroyed railroads or highways. Of the railway construction companies in the German armies, some 66 or over two-thirds of the total were assigned to the Western Front. This gave them approximately 19,000 men well trained and well versed in their duties. Foresight had been exercised in equipping these units, and plans for their use in closely following the advance had been thoroughly worked out. In a word, the Germans were prepared to cope with demolitions, and when war was declared, the railway troops accompanied the leading elements of the cavalry across the border and were at work long before the main columns moved into enemy territory (*32*).

B. PLAN IN EXECUTION

As you recall, I previously stated that demolitions on the Aix-la-Chapelle-Liege-Brussels-Mons-Valenciennes line had been relatively light. As a result, the reestablishment of this line was fairly simple and required but little time. However, as the advance penetrated further into the plains of northern France and entered regions where the demolitions had been much more thorough, the commanders realized the enormous amount of work necessary to reestablish the lines. Not only was it essential to press more railroad troops into service, but it became absolutely imperative to utilize the personnel and facilities of private bridge construction firms (*33*).

In order to substantiate deductions drawn later in this paper as to the probable situation had demolitions in the northern area been more complete, it is believed wise to present at this point several illustrations as to the time required to repair or reconstruct a few of the structures damaged by the Allied demolitions (*34*).

(*a*) A single-track steel bridge over the Meuse at Namur, to reestablish the Namur-Luxemburg lateral was started September 8 and completed September 30 by private contractor. This was considered excellent speed (*35*).

(*b*) Steel viaducts near Hirson were built by contractors in the following number of days (*36*):

	Days
Blangis	43
Origny	46
Ohis	37

(*c*) Bridges constructed by field methods in times shown below (*37*):

	Days
Bazeilles (pile trestle, 100 meters long)	10
Doncherey (pile trestle, 110 meters long)	11

(*d*) Tunnels were repaired as follows (*38*):

	Month	*Days*
Longuyon	1	22
Liart	1	9
Montmedy	8	

In all cases detour lines were or probably could have been built in shorter time if desired, for example, at Montmedy a detour railroad was built in 10 days.

C. EFFICACY OF THE GERMAN PLAN

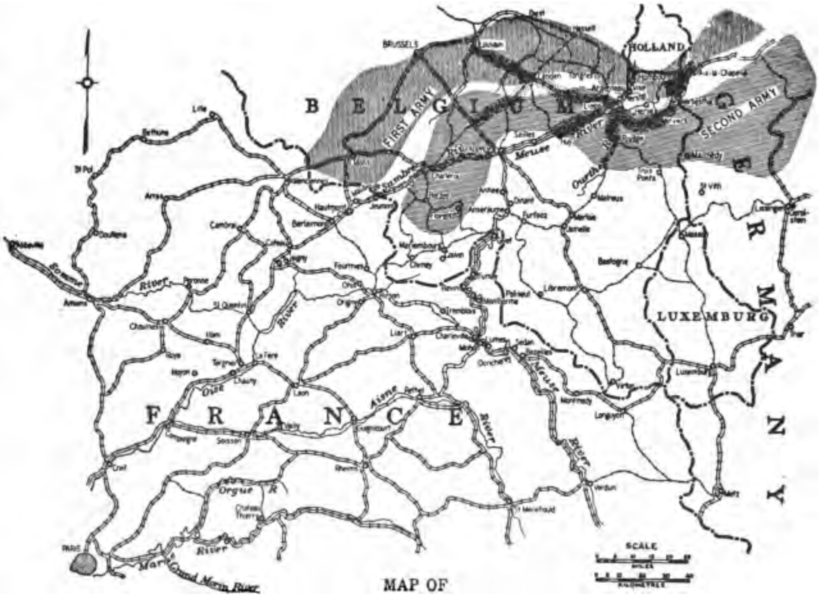
With all due respect to the German engineers and their plans of operation, it is not, strictly speaking, quite fair to give them the

---

(*32*) No. 1, pp. 60, 61; No. 3, pp. 314, 316.
(*33*) No. 1, p. 61; No. 3, p. 318.
(*34*) No. 3, pp. 316–319.
(*35*) No. 3, p. 318; No. 6, annex 14.
(*36*) No. 3, p. 319.
(*37*) No. 3 p. 317.
(*38*) No. 3, pp. 316–319.

entire credit for their splendid showing in repairing the railway line and thus making possible the amazing rate of advance enjoyed by the First Army. We must keep in mind the fact that Allied demolitions in their zone were relatively feeble and thus permitted the Germans, with a minimum of effort, to keep their railheads close to the leading elements, during the initial stages. However, in those areas where the Allies had done more effective destruction, we see the rate of reconstruction was materially reduced (see pl. 7–12).

The double-track line behind the right wing received, as previously stated, little serious destruction. As a result, its reconstruction advanced rapidly: On August 22, it reached Landen, by the 24th Louvain (while the leading troops were south of Mons), by the 26th the line touched Brussels, and on the 29th Mons. At this time the troops were just southwest of Chaulnes. Five days later the line reached Chaulnes, and on September 4 had gained Roye and St. Quentin (via Busigny). By this time the leading assault echelons had crossed the Marne. It is interesting to note that till this point the only serious demolitions took place near La Fere, and they were of such magnitude that the line St. Quentin-La Fere was not reopened. On September 9 the railroad reached Compiegne and on that same day started the Battle of the Marne, which was destined to halt the onward surge of the Germans. In the first army zone the engineers had kept well apace with the advance; the railheads were within favorable distance of the front lines (about

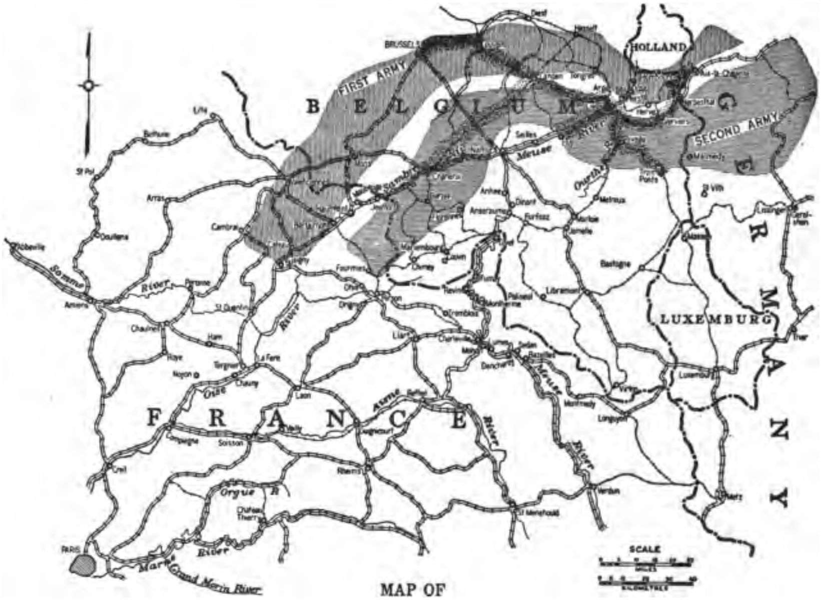


MAP OF
NORTHERN FRANCE AND BELGIUM
ADVANCE OF RAILHEADS AND TROOPS TO INCLUDE AUGUST 24

PLATE 7.

50 miles back), made possible primarily by a lack of strategically important demolitions on the part of the Allies (*39*).

In the zone of the Second Army not quite the same favorable picture exists. At first, a rapid extension of the railhead was accomplished. From Landen south, the single track line was opened to Charleroi by August 25, while that same day troops reached the northern frontier of France; on the 30th to Fourmies with the troops at St. Quentin, and on September 5 to Fumay via Florennes-Mariembourg. The rapid extension to the south had been stopped by the demolitions near Hirson, and, though the troops themselves were well below the Marne by September 5 their railhead was over 100 miles to the north at Fourmies, while the single line used to supply the Third Army only reached Tremblois on the 6th via Couvin and Charleroi (*40*).



MAP OF
NORTHERN FRANCE AND BELGIUM
ADVANCE OF RAILHEADS AND TROOPS TO INCLUDE AUGUST 26

PLATE 8.

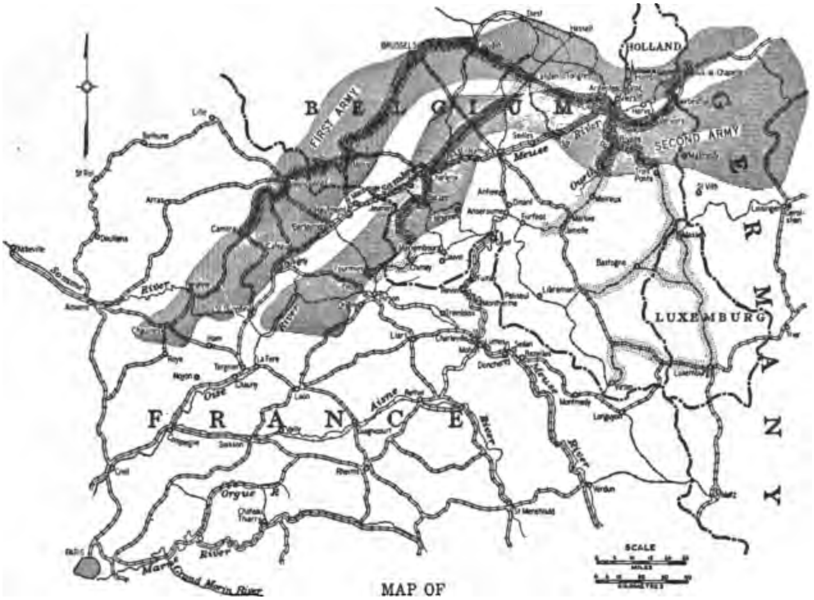
The double track Liege-Namur was blocked by both the destroyed tunnel at Seilles and the forts at Namur. After the fall of Namur and Maubeuge this line was opened to Charleroi by September 3 and not to Maubeuge till after the battle of the Marne (*41*).

On the Belgian railroad lying east of the Meuse service was resumed on the stretch from Bastogne to Libremont and Paliseul on August 30 and the next day the Trois Ponts-Rivage-Jamelle-Anserenne line was opened (*42*).

(*39*) No. 1, pp. 62, 63; No. 3, p. 316.
(*40*) No. 3, pp. 316, 317; No. 6, annex 13 and 14.
(*41*) No. 3, pp. 316, 317; No. 6, annex 13 and 14.
(*42*) No. 3, p. 317.

Further to the south running west from Luxemburg was a double track line that might have served as an admirable source of supplies for the German Second Army had Allied demolition there been less severe. However, so effective were these demolitions that not till August 30 did the line reach Montmedy; and on September 15 after the construction of a detour around Montmedy had been completed, train service was furnished to Rethel via Virton-Montmedy-Sedan-Mohon (this was after the Battle of the Marne (*43*)).

Clearly the foregoing illustrates the value of well-planned and well-executed demolitions. The railroads in the zone of the First Army, damaged by relatively few and unimportant Allied demolitions, were speedily repaired and the reconstruction kept a favorable pace with the fast moving troops. On the other hand, in the zone of the Second Army where extensive Allied demolitions had been accomplished, the railheads fell far behind the leading troops and seriously hampered the problem of supply.



MAP OF
NORTHERN FRANCE AND BELGIUM
ADVANCE OF RAILHEADS AND TROOPS TO INCLUDE AUGUST 30
PLATE 9.

D. EFFECT OF RAILROAD DEMOLITIONS ON THE GERMAN RIGHT WING

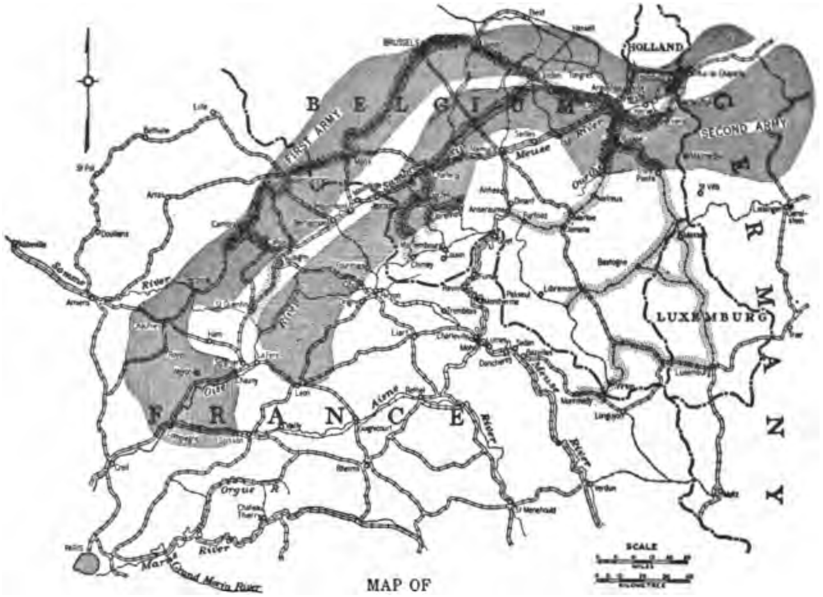
Insofar as this subject is concerned, we will confine ourselves only to adverse effects such demolitions may have had on the efficiency of supply and evacuation, and movement of material and troops (including transfer of reserves laterally between the armies). It must be borne in mind that the German Staff expected extensive

---

(43) No. 3, p. 317.

destruction of railroads and to assure an ample supply of material and personnel for the main advance of the right wing, they had concentrated considerable truck equipment behind these units (*44*). As a result, the supply of these armies was not solely dependent upon the railroads and, in some measure, the effect of railway demolition was nullified.

The blocking of the Liege-Namur line was, in itself, a very masterful stroke. But, by itself, it was not sufficient to bog down the German advance. Until well in September, the entire line of supply of both the First and Second Armies, several cavalry divisions and the force investing Antwerp, was limited to the one railroad: Aix-la-Chapelle-Liege-Louvain-Brussels and its extensions (*45*).



MAP OF
NORTHERN FRANCE AND BELGIUM
ADVANCE OF RAILHEADS AND TROOPS TO INCLUDE SEPTEMBER 1
PLATE 10.

Via Liege also went the supplies for the Third Army, its railheads were advanced as the lines; Liege-Namur-Charleroi-Couvin, and Liege-Jamelle-Dinant were slowly extended (*46*).

As to the adequacy of supplies in the First Army, it is believed that Generals von Kuhl and von Bergmann may be taken as authoritative and statements from their book, Movements and Supply of the German First Army, are quoted:

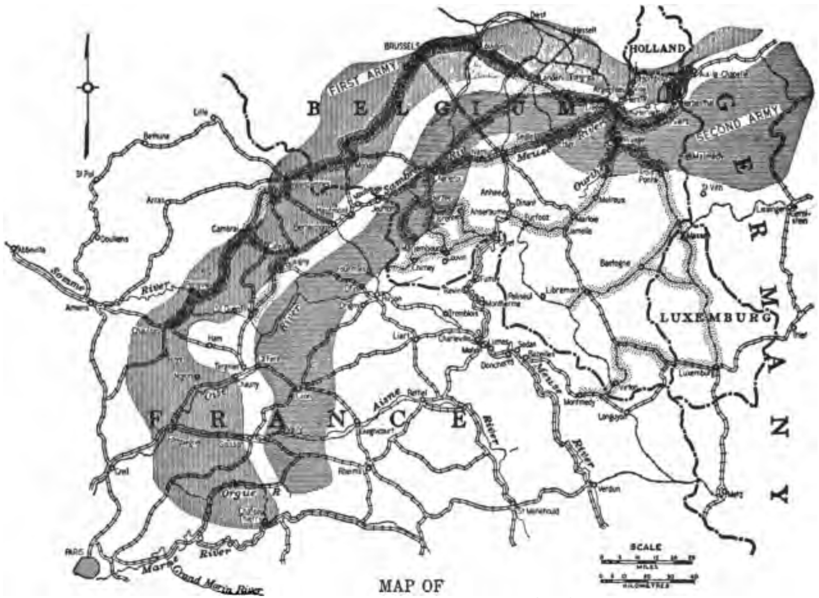
> (a) There was no shortage of subsistence during the Battle of the Marne; similarly there was no shortage of ammunition which might have had a decisive influence upon the situation after the battle (*47*).

(*44*) No. 16, p. 97.
(*45*) No. 1, pp. 41, 149, 150, 217.
(*46*) No. 1, pp. 41, 149, 150, 217; No. 15, pp. 3, 9.
(*47*) No. 1, p. 54.

(b) Generally speaking, the ammunition supply service, during the entire advance of the First Army, proved adequate * * * (*48*).

(c) From a technical point of view one may therefore say that the railway situation on the right wing of the armies at the time of the battle of the Marne was unexpectedly favorable and adequate so far as the supply service was concerned (*49*).

The situation in the Second Army relative to supplies is not so readily brought to light. In the references consulted, there appears to be a noted lack of information and, actually, we find no authoritative German source. Speaking for the Allies, however, the Belgians emphatically stress the importance of their work in destroying the tunnel at Seilles (east of Namur) and the railroad in that vicinity on the through route from Liege to Maubeuge (*50*). They state that this prementioned line was not reestablished until September 5, and as a consequence, the Maubeuge investing force was deprived of a direct and assured route of supply prior to that date. Till that time supplies were necessarily limited as they had to be routed over the main line, Liege-Louvain, already taxed to capacity by the right wing armies. Thus, it was only with great difficulty that these forces could be supplied, and, in spite of all efforts to the contrary, the movement of artillery from Namur and infantry from Liege was delayed, resulting in immeasurably slowing up the operations at Maubeuge. Indeed, the Belgians even quote General von Zwehl, commanding the forces investing Maubeuge, as reporting on August 29, 30, 31, September 1, 3, 6, and 7,

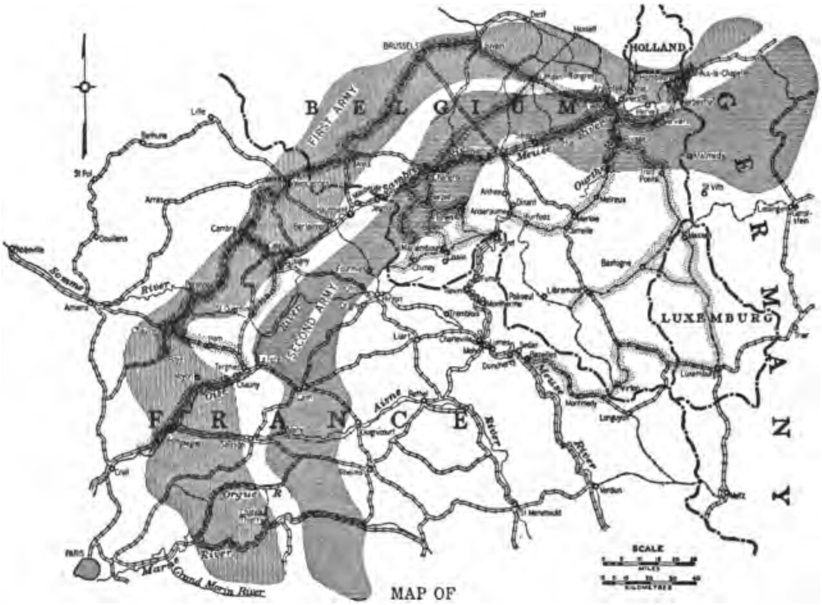


MAP OF
NORTHERN FRANCE AND BELGIUM
ADVANCE OF RAILHEADS AND TROOPS TO INCLUDE SEPTEMBER 3
PLATE 11.

(*48*) No. 1, p. 55.
(*49*) No. 1, p. 63.
(*50*) No. 6, annex B.

the lack of sufficient artillery ammunition and a failure to have his requisitions filled. In the final analysis, then, this prolongation of the siege held two needed German divisions here during the decisive crisis of the Marne (*51*).

While the writer has consistently remarked upon the poor Allied demolitions near Liege and on the Nord railway system it has also been stressed that the work in the vicinity of Namur and on the L'Est System was much superior, and it is these latter demolitions that made more difficult the German advance. These demolitions were especially effective in hindering the lateral movement of reserve troops. This is rather aptly illustrated by quoting from von Tappen as to the withdrawal of two corps from the right wing for service on the eastern front (*52*):



MAP OF
NORTHERN FRANCE AND BELGIUM
ADVANCE OF RAILHEADS AND TROOPS TO INCLUDE SEPTEMBER 9
BEGINNING OF THE BATTLE OF THE MARNE

PLATE 12.

> The fact that these two corps were sent by marching from Namur to Aix-la-Chapelle, Malmedy and St. Vith to be entrained at these points shows more clearly how bad the rail situation was in Belgium at that time in the right wing of our armies. It was a fact that we had to note again on this occasion because the question had been previously discussed concerning the reinforcement of the right wing by forces taken from the left wing.

He further states (*53*):

> It was not until September 4, shortly before the Battle of the Marne * * * when rail communications with the right flank were improved that it was decided to withdraw the Seventh Army from the front and transport it to the right wing.

---

(51) No. 6, annex 13.
(52) No. 16, p. 111.
(53) No. 16, p. 100.

Again illustrating the difficulties attending lateral movement of troops and remembering the railroad bridge over the Meuse at Namur was not completed until September 30, we quote the Belgian Ministry of Defense (extracting from the Reich Archiv) (*54*):

> The lack of rail communications did have an adverse effect on the Battle of the Aisne. The XV Corps, notably, would have arrived earlier if it had been sent to Belgium via Namur-Brussels instead of through Liege; it could have been wholly engaged in that case with the VII Reserve Corps on September 13, whereas its first detachments only could intervene. Likewise, the I Bavarian Corps would have arrived on time at the scene of battle, if it had not had to detrain at Namur. One brigade of this corps crossed the river on foot at Namur and reentrained on the north side and was moved via Charleroi-Mons to Noyon. It arrived the afternoon of September 18 on the right of the First Army and reached the field of battle on the 19th, whereas it could have arrived 2 days earlier and been accompanied by the rest of the I Bavarian Corps if the railroad bridge at Namur had been available. The I Bavarian Corps, however, was obliged to march and did not arrive at its destination until September 23 in the region of Peronne. The XXI Corps which was also transferred to the right wing did not arrive near St. Quentin until September 22, because it had to move by Trier-Gerolstein-Aix-la-Chapelle-Liege. Finally, the II Bavarian Corps, whose trains followed those of the I Bavarian Corps, was obliged, like the latter, to detrain south of Namur and march by road; it did not arrive in the vicinity of Peronne until September 25.

E. RAILROAD DEMOLITIONS—SUMMARY AND OPINION OF AUTHOR

Both sides realized the tremendous strategic value of the main line railroads in the zone of advance and fostered definite plans for their control or destruction as the case may be.

On the Allied side, while plans did exist for the destruction of the lines in the event of invasion, only in the area around Namur and south thereof can their labors be said to have been highly effective. In the zone of the First Army, so feeble and ill-coordinated were the efforts that the Germans felt little shortage of supplies and were able to advance at the very impressive rate of 15 miles per day (*55*).

Only after the Marne, was any appreciable effect noticed in the right wing. This was the delay in the movement of the reserves shifted from the left to the right, and was caused primarily by the destruction of the Namur bridges and the Seilles tunnel.

It is the opinion of the writer that the errors in the execution of demolitions are, primarily, contained in the work around Liege. The commandant at Liege had roughly 6 days between July 29, when he started to clear his forts, and August 4, when the Germans crossed the Belgian frontier, to have thoroughly destroyed a number of bridges and tunnels between Aix-la-Chapelle and Liege. Till August 6 he could have destroyed the vital railroad bridge over the Meuse at Liege, and the steep viaduct and grade on the double track leading to the plateau above. Likewise, it is believed, there was ample time for the Belgian field army to have destroyed bridges on the retreat to Brussels.

Realizing that quite definite plans had been made prior to the war by the Belgians for demolition of strategically important structures, it is difficult to understand why the results were so mediocre. Per-

---

(*54*) No. 6, annex 14.
(*55*) No. 2, p. 26; No. 4, p. 2.

The number of galleries planned for will give a measure of the technical troops required. In the British service, mining troops, under normal conditions, are supposed to work underground only one-fourth of the time; this, for the reason that the work is much harder than that which falls to the average soldier. In time of emergency, troops are, of course, kept underground much longer and a company has been known to be on duty for 36 hours. An experienced British mining officer informed me that under average conditions in rocks no harder than chalk it is safe to count on about 2 feet of heading per week for each miner in the company.

The relief for one heading usually consists of from 12 to 18 men distributed as follows: Three men at face, one man hauling from face to foot of incline, two men hoisting, one man on blower, and four men on the dump. In addition, other men may be needed for transporting of spoil and timber and to manipulate pumps. At average depth, two men using a small car on light rails can hoist the spoil up an incline from two headings driven in chalk at an average rate of 10 feet per day. The above facts give a rough measure of the number of men required for driving galleries. Sinking of shafts or inclines is slower, but there are so many variant factors that neither the probable rate of progress nor the number of men required can be expressed in definite figures. Then, too, the sinking of shafts is more likely to be seriously interrupted than the work in galleries. It is evident also that shelling may stop the advance of galleries by damaging the shaft or by the prevention of surface disposal of spoil.

AVAILABILITY OF TOOLS, MINE TIMBERS, ETC.

The choice of tools and other equipment will depend on the physical conditions as set forth above, which make it evident that different equipment will be needed for hard rock and for soft material. If power drills must be used, which has not been the case on the British front, more elaborate equipment will be necessary, including air compressors or electric motors. All galleries 60 feet or more in length will be artificially ventilated and therefore blowers, fans, or power-driven ventilators must be installed. Though it is seldom possible to carry on military mining below the depth of ground water, yet equipment for handling seepage water is usually necessary. Where the entrance is by shaft or incline hoisting equipment must be had, and this may be by block pulleys, by an improvised windlass, or by hand or electric hoist. The last, like other power equipment, has been little used by the British on account of the difficulties of installing and maintaining transmission lines. The amount of timber needed will depend on the physical conditions of the formations traversed. Estimates of quantities of explosives will be based on the plan of operations, depth of mine, and physical character of formation.

While ample provision of matériel must be made, an oversupply must be guarded against. An excess is not only a waste of equipment that may be needed elsewhere but also entails useless transportation, blocking the line of communication, as well as presenting difficult problems of storage at the front. The ideal to be aimed at is to have the timber delivered only as fast as needed. Though an excess of matériel must be guarded against, there must, during active underground warfare, always be enough to meet every emergency.

PLAN OF OPERATION.

No mining should be undertaken without a definite plan of operation formulated on the basis of as full information as possible regarding the physical conditions. Therefore, the first step will be to study the ground and, if none

BIBLIOGRAPHY

(*1*) Kuhl, von, and Bergman, von. (Generals, German Army): "Movements and Supply of the German First Army during August and September 1914," Command and General Staff School Press, 1929.

(*2*) Baills, Colonel: "Giberne de Sapeur," Revue Militaire Francaise, October 1932.

(*3*) Kretzschmann, Dr. Wilhelm Von, Formerly Major, German General Staff: "German Reconstruction of Railroads," The Military Engineer (July–August 1925), Vol. XVII, No. 94.

(*4*) Dumont, George A. L., Brigadier General, French Army: "Major Demolitions in Time of War," The Military Engineer, (January–February 1927) Vol. XIX, No. 103.

(*5*) Kluck, Alexander, Von, Generaloberst: "The March on Paris and the Battle of the Marne, 1914," Longmans, Green & Co., New York, 1920.

(*6*) Ministers de la Defense Nationale-Etat-Major General de l'Armee, Royaume de Belgique: "Defense de la Position Fortifiee de Namur en Acut, 1914," J. Havlange, Bruxelles, 1930.

(*7*) Poseck, M. Von, Lieut. Gen. and Inspector of Cavalry, German Army: "The German Cavalry, 1914, in Belgium and France," E. S. Mittler & Sohn, Berlin, for the U. S. Cavalry Association, 1923.

(*8* Somville, Gustave: "The Road to Liege," Hodder and Stoughton, London, 1916.

(*9*) Belgium, Ministry of National Defense: "Campaign of the Belgian Army July 31, 1914–Jan. 1, 1915," Translation in Command and General Staff School Library.

(*10*) Dane, Edmund: "Hacking Through Belgium," Hodder Stoughton, London, 1914.

(*11*) Galet, Lt. Gen.: "King Albert in the Great War," Putnam, London, 1931.

(*12*) Johnson, Douglas Wilson, "Topography and Strategy in the War," Henry Holt and Co., New York, 1917.

(*13*) Marchand, A.: "Les Chemins de Fer de l'Est et la Guerre de 1914–1918," Berger-Levrault, Paris, 1924.

(*14*) Howland, C. R.: "A Military History of the World War," General Service School Press, 1923.

(*15*) Robinson, Major Wm. F.: "Supply and Transportation, The German Campaign in the West, 1914," Manuscript in Command and General Staff School Library, 1923.

(*16*) Tappen, General de Division en Retraito "Jusqua La Marne en 1914," article contained in the book, "Documents Allemands Sur La Bataille de la Marne," Payot, Paris, 1930.

the transmission of sound, and also, together with the depth of the overhead cover, determines the radius of destruction of mine explosions.

If the formation is such that it can be easily excavated and with but little sound, it will be possible to make feint attacks combined with flank attacks. A feint may be made by driving a heading directly toward the enemy with an undue amount of noise, while at the same time a flank attack is in progress by another gallery. The latter is driven with as little noise as possible. Such tactics are seldom practical if the material to be excavated is chalk or harder rock, because it is not then possible to do the work quietly enough to deceive the enemy. If, however, the formation be clay, giving the most favorable conditions for underground attack, it is sometimes possible to penetrate the enemy's works before discovery. Under such conditions preparations are made for hand-to-hand underground fighting, such as has taken place many times on the British front. The British, however, discouraged such fighting, as it seldom leads to any decided tactical advantage. These skirmishes have, however, the merit of developing the morale of mining troops, and thereby intensifying their interest in the work in hand.

When the works of the enemy are penetrated the first duty is to cut the wires and remove the detonators of any mine found in place. This accomplished the explosive is removed. As a general rule, the enemy's gallery is then blown up as far back as circumstances permit. Under some conditions it may be best to try to hold the enemy's gallery instead of destroying it. This will call for the building of traverses or barricades with sandbags and the maintaining of a defensive guard. If time permits a survey of enemy's works should always be made.

Surprise attacks, such as the above, are the exception rather than the rule in the face of an alert enemy. In general, reliance is placed on rapidity of advance rather than on silence in operation. In hard rocks requiring drilling, the enemy can best be deceived by making an inordinate amount of noise in the operations. It has been stated that this sound of pneumatic drills is exceedingly difficult to locate accurately. Therefore, if the equipment be at hand the driving of several galleries in hard rock with the use of pneumatic drills may be a very effective mode of attack.

Various ruses for deceiving the enemy are also used. When the countermines are close at hand, mechanical devices operating from a distance which simulate the sound of a pick or shovel, may induce the enemy to explode a camouflet. The simulation of the charging and tamping a mine may also lead the enemy to make an attack. Mine explosions always wreck to a greater or less degree the enemy's own gallery, as well as his opponent's. It thus may interrupt the progress of his own mining, while his opponent advances from another direction.

Though the explosion of a camouflet reveals the proximity of the enemy, yet experience has shown that it gives little definite clue to the direction of the mine chamber. The survivors of such an attack usually make only hazy and conflicting statements regarding the direction of the shock, and as the gallery has been wrecked, no direct evidence is obtainable. The British made some experiments in the use of the seismograph for determining direction of mine explosions, but the results are reported to be negative. It appears that the earth waves induced by the explosion are more or less uniformly projected in virgin ground of unbroken strata and that their center of origin can be determined by the seismograph. The waves are, however, so greatly deflected by rock structures or by shell and mine craters, and their attending earth ruptures, the normal conditions at the front, as to make it impractical to determine the center of explosion by the use of the seismograph.

The explosion of a mine will reveal the position of the chamber by forming a crater. Hence, only camouflets are used for the destruction of countermines, and the changes are carefully gauged to bring about the desired results. If too much, it wastes the explosive, shatters a larger zone than necessary, and in extreme cases may form a surface crater. Excessive shattering of the bedrock is to be avoided unless deliberately done to impede the enemy, for it greatly increases the difficulties of subsequent mining. Charges may be placed in the end of attack or defensive galleries and tamped with sandbags, or may be placed in specially prepared chambers. (Figs. 9, 10, 19.)

Usually a mine will not be exploded until the objective of the attack has been reached, and all preparations for the advance by the infantry made. This grand attack may include the simultaneous explosion of many mines in separate chambers or galleries. At Messines Ridge, 19 mines were exploded at one time, charged with a total of about 1,000,000 pounds of ammonal.

It should be noted that simple mining operations are sometimes used for the sake of advancing the field works. These may be projected at shallow depths toward the enemy, and when the proper position has been reached an explosion of a mine will form a surface crater. This crater is then occupied by the infantry as soon as the fumes have been dissipated. These are generally local attacks and are not coordinate with a general system of underground warfare. Another use made by the British is as follows: A small gallery is driven at shallow depths from the front-line trench. Within this gallery is placed a boring machine (fig. 15) capable of excavating a hole to 6 inches in diameter. A horizontal hole is then drilled to within a short distance of the enemy's trench. When the time for the attack is at hand, the hole is extended through to the enemy's trench and a pipe charged with explosives inserted in it.[17] The explosion of this will open up a passageway through the barbed wire entanglement and into the enemy's trench. It has been found that sufficient explosives can be inserted in this way to lift 14 feet of soil and subsoil. This mode of attack obviously has no relation to underground warfare, though the operations are carried on by mining troops.

MINING SYSTEM.

The plan of a mine system will be based on the tactical situation, modified by the physical conditions already considered. Two general systems are used: (1) A series of independent galleries driven more or less directly toward the enemy, with branches for attack, flank protection, and listening. (See fig. 7.) This is called the "fishbone type." It is preferred by the French (see fig. 9) and generally used by the Germans (see fig. 10). (2) A lateral gallery parallel to the front line, from which parallel attack, defense, and listening galleries are projected toward the enemy. (Fig. 8.) This may be called the "lateral type" and was most used by the British. (See fig. 19.)

The fishbone type, long used in mine warfare, has the advantage in that the work is concentrated on an advance toward the enemy. French officers claim the additional advantage that each mine being independent there is less interference in the handling of spoil from different headings than in the case of the lateral type. Such criticisms do not appear to be justified, for the ease of transporting spoil from the heading to the surface will depend on the size of the galleries and number of entries. Moreover, the free system of intercommunication offered by the lateral type will facilitate rather than hamper underground traffic. A more serious criticism, also made by the French, of the lateral type is that all the works being communicating, the gases being developed by mine explosions will permeate the whole system. This, however, may be guarded against by gas-proof doors which will, however, hamper communication. Another objection made by the French is that if a countermine reaches the lateral

---

[17] The French use a boring machine for a similar purpose. See Mining Operations, Especially for Infantry, by Col. W. R. Livermore, U .S. Army. Professional Memoires, Corps of Engineers, U. S. Army, vol. 10, 1918, p. 130.

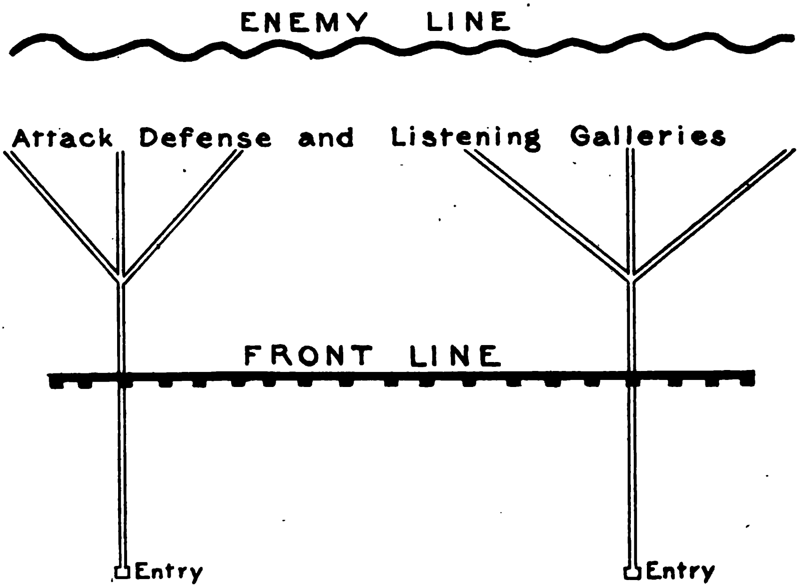


FIG. 7.—Diagram of fishbone mine system.

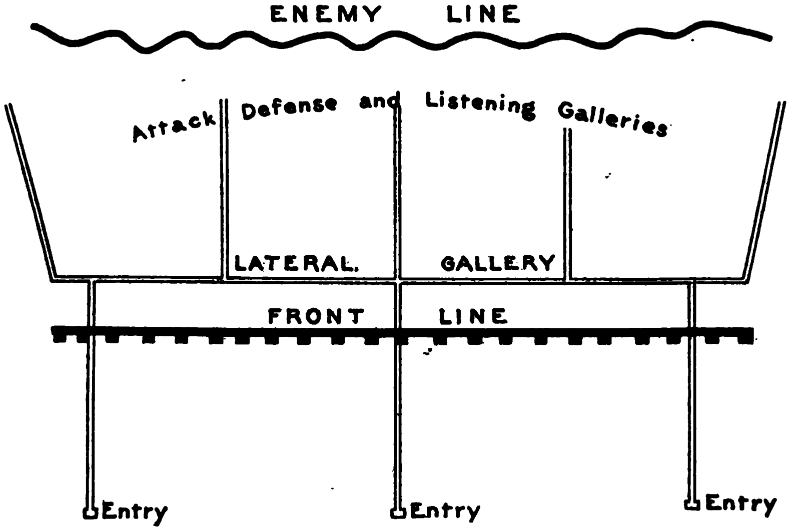


FIG. 8.—Diagram of lateral mine system.

gallery, the whole system may be interrupted by one explosion. This is provided for by keeping the lateral gallery far to the rear and not over 100 feet from the front-line trenches. If the enemy reaches that close he will expose himself to flank attacks.

Whatever may be the relative advantages and disadvantages in attack it seems certain that the lateral type first developed by the British is the best for defense. (Fig. 19.) This type makes it impossible for the enemy to reach his objective without penetrating the opponent's works. On the other hand, in the fishbone type there is always the chance that the enemy may penetrate between two galleries. (Figs. 9 and 10.) It is in general true, however, that in any extensive mining system, both types will be more or less used. (Fig. 9.)

Military mines with galleries at two levels have long been used in underground warfare. In many cases they have been the result of change of system enforced because of ignorance of the physical underground conditions rather than to a deliberate plan. One of the conditions that may lead to a two-leveled mine is the unexpected meeting with ground or artesian water, thus forcing the abandonment of the lower workings. The seasonal fluctuation in ground-water level may also force the mine to be continued at a higher level. An offensive mine system on two levels is sometimes made as a part of a deliberate plan. In this, the upper gallery may be a feint to deceive the enemy, while the actual attack is made at greater depth. This mode of attack (see fig. 11) has been considerably used by the French.

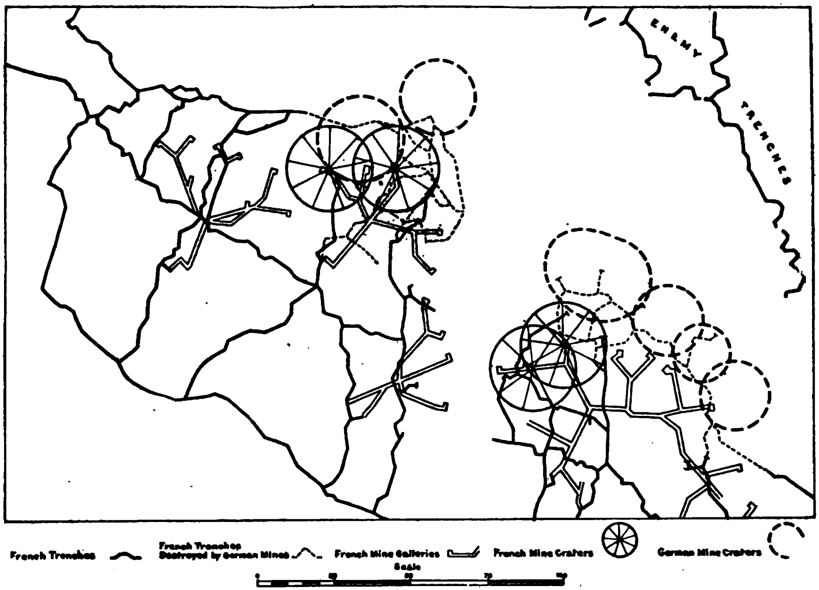


FIG. 9.—Plan of French mines, fishbone system, near Flirey, Lorraine.

DEFENSIVE MINING.

Most of the principles already presented relating to offensive mines apply with equal force to defensive mines. An adequate defensive mining system can only be established before the enemy has begun countermining. When once the two sides are in contact, offensive mining is the only policy which will give an adequate defense.

If, however, defensive mines are established before the enemy begins his work it is possible to keep quiet and await the attack. Under these conditions the enemy is at great disadvantage in not having the usual clues, such as noise of excavation, and recognition of fresh spoil dumps to guide him in the location of the underground works. Absolute secrecy as to the mine plans, though always important, is especially essential under these conditions. To assure this only the minimum number of men necessary for mine guards should be given access to the mine. This is to prevent, so far as possible, information reaching the enemy through prisoners, deserters, and spies.[18] No plan of the mine should ever be taken forward to within reaching distance of the enemy's trench raids.

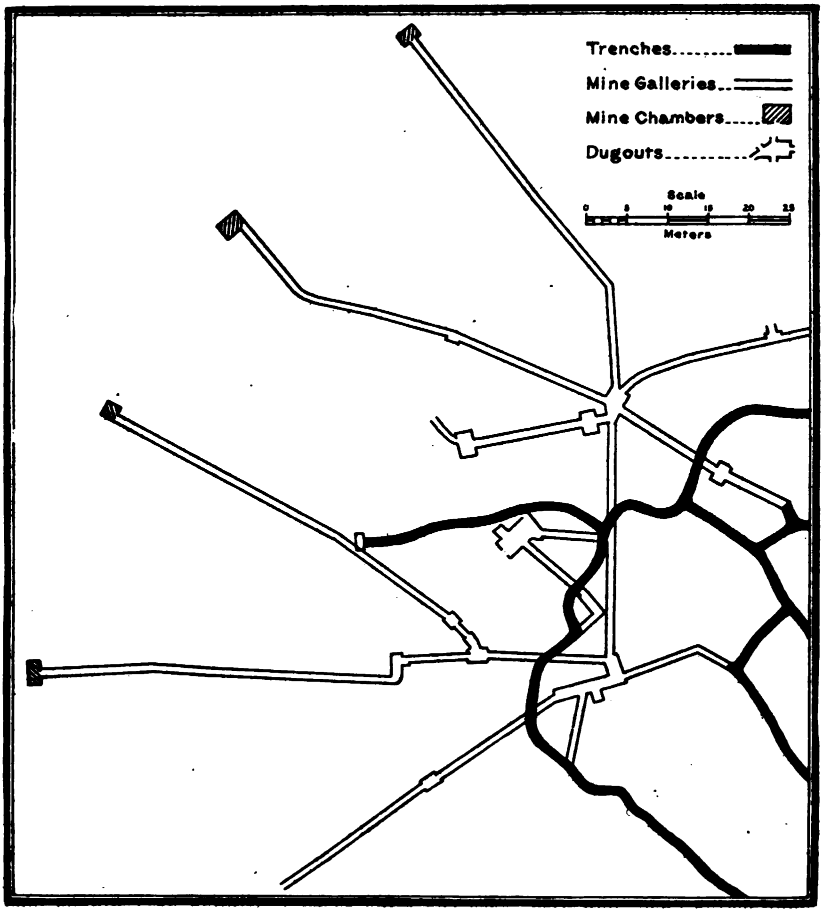


FIG. 10.—Plan of German mines, fishbone system, near Vauquois Hill, Argonne.

---

[18] At the siege of Sebastopol the Russians are reported to have obtained knowledge of the position of a French attack gallery from a plan of the siege operations published in Paris during the war. Sebastopol Guerre de Mines by F. Tailllade, Capitaine du Génie, Paris, 1906, p. 16.

One system of defensive mining that was examined consisted of a lateral gallery, parallel and about 100 feet in front of the firing trench, extending for over 5 miles. (See Fig. 19.) From this lateral, listening galleries, at an interval of about 60 feet and never more than 100 feet, had been projected toward the enemy. Each sector was provided with an underground listening post connected by wires with the heads of the listening galleries and here a listening guard was kept on duty at all times. Each sector also had a fully equipped first-aid and rescue station manned by a detail of soldiers trained in the mine-rescue work. This system was at ground-water level, hence there was no danger of its being undermined by the enemy. Each sector was occupied by units of mining troops and no one else was permitted underground. The mine guards were housed in comfortable, well ventilated dugouts, and the whole system was electrically lighted, the seepage water being handled by electrically driven pumps. Two dynamos driven by gas engines located near the two ends of the system supplied the electricity. Both of these had the capacity to carry the full load so that if one were destroyed the other could supply the power. The system was supplied with running water pumped from a well sunk from the mine workings.

When opposed by an aggressive enemy, defensive mining, no matter how elaborate the underground workings may be, will never give assurance that the position can be held. When once in contact with the enemy the defender must be prepared to take the offensive, for otherwise the enemy will eventually penetrate his works.

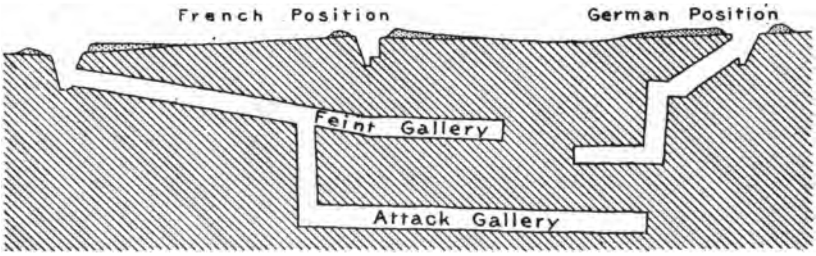


FIG. 11.—Diagrammatic cross section of French mine attack on two levels.

SHAFTS AND INCLINES.

The obvious advantage of making mine entrances through self-drained galleries will, where the terrain permits, preclude the choice of any other type. Other entries are by shafts or inclines, or by combination of the two. The advantages of the shaft are that it is easy to construct, will reach the required depth in the shortest distance, and can be sunk through wet ground. Its disadvantages are that it is very vulnerable to artillery fire, can be defended only by surface works, is difficult of egress and affords no protection to miners during construction. Moreover the standard gallery frames can be used for lining an incline, while the shaft requires special timbers. Inclines also afford better ventilation than shafts. The crude methods of hoisting, which the conditions generally impose, are better adapted to inclines than to shafts. It was for these reasons that the British abandoned their earlier practice of using shafts almost exclusively and adopted the incline as a standard entry. The shaft, however, still finds its use in wet grounds.

The French, however, by preference used gently sloping galleries as mine entries. (Fig. 11.) This does not differ essentially from the British practice harder rocks only the roof is completely lined. Wooden steps are made in the inclines to give easy communication.

Incline entrances are often made double, the plan being V shaped with the apex underground. (See fig. 12.) Where a position is subject to much shell fire a hoisting station is often put in part way up the incline.

In defensive works, and where the mine entries are at or near the front line, provision is usually made for their defense. The defense of incline against infantry and grenades is made by loop-walled traverses between the gallery and the bottom of the incline. Entrance from the gallery is made by a passageway around the traverse which is separated from the incline by a door. Methods of traversing inclines are illustrated by the accompanying sketch. (Fig. 12.) Usually a sump is placed on the foot of the incline as a trap for hand grenades.

Gas protection is secured by doors placed about midway on the incline. The most frequently used type is made of blankets fastened at the top and nailed to a flat roller at the bottom. This blanket door is fitted so as to overlap a light wooden frame. Another type consists of a light framework covered with cloth and hinged at the top. This is fit snugly into a cloth covered frame. All gas doors are double and are spaced from 4 to 10 feet apart. Mine openings into dugout galleries or subways are provided with gas doors often fitted with small openings closed by a slide through which a canary can be inserted for gas test.

GALLERIES.

Mine galleries are classed as main or common galleries, which are used as haulage ways and branch galleries used for attack, defense, or listening. The main galleries usually have a dimension of about 6½ by 3 feet. It has been shown by experience that except in extreme urgency it is not good practice to make the main galleries too small, for while they can be more quickly excavated than the large ones and there is a saving in timber, they are a serious handicap in handling spoil, explosives, etc., in such cramped quarters. In time of active underground warfare it may not be possible to make the large galleries, and headings are then driven of such dimensions as conditions permit and later enlarged if extensively used. The branch galleries are of various sizes, varying from 4 by 3 feet in cross section to small holes excavated by men lying down, the latter, of course, only made in extreme emergency. At first neither the British nor the French attempted to standardize the dimensions of their mine workings. As underground work developed on a large scale, it was found that there was much loss of time due to this lack of standardization, and as a result standard sizes were fixed by regulation for which timber was furnished.

Main galleries are usually straight so as to facilitate the communication. Alignment of attack and listening galleries is varied to suit the tactical situation and the physical conditions. An attack gallery is often given an offset consisting of two right angled bends just before it reaches the point where camouflet is exploded or counter-mining is expected. This feature is called a "dog leg" and is intended to prevent the explosion from destroying the main part of the gallery. The nearest point of the dog leg should be at least 25 feet from the camouflet and the offset should be from 6 to 10 feet. (Fig. 13.)

In chalk, the timbering consists of sets spaced on 3 or 3½ foot centers, and these are often placed without sills. In harder rock, wider spacing is used. The roof is usually lagged with plank, but the walls where the rock is found are without lining. If the rock be hard but shattered, they are lined with light sheeting. The sets are made of round or square timbers with a diameter of about 6 inches. No notching is done as it is claimed that this weakens the timber. The props or stanchions are held in place by spreaders nailed on the caps or sills, of such length as to leave a 6-inch recess at both ends. One to one and a half inch planks are used for the roof, and in case of greatly shattered rock the same material may be used for the walls. Under other conditions, only very light lining for the walls is necessary. The light wooden frames with expanded metal caps made for revetting trenches have been found to be well adapted for light wall lining. It is needless to add that in mining hard and unbroken rocks the amount of timber is very much less. When close to enemy and a surprise attack is being carried on, screws instead of nails are used in underground work.

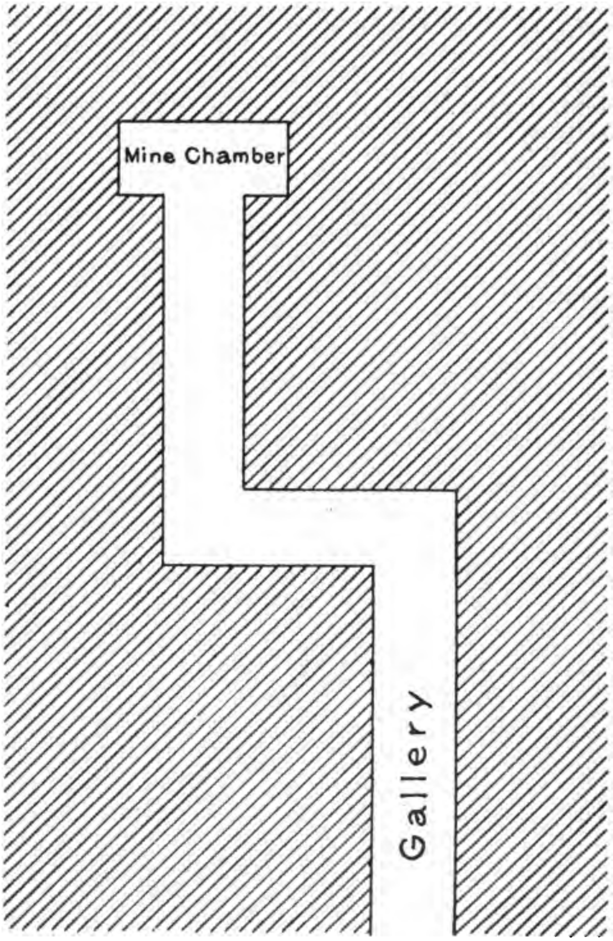


Fig. 13.—Plan of dog leg in attack gallery.

Most of the mining is at such depth that there is ample head cover against shells. The minimum is 25 to 30 feet in clay, 20 feet in chalk, and less for harder rocks. If the mine is under very shallow cover steel girders may be used in lieu of caps, these being held in place by iron shoes placed on the props.

Galleries in clay or other loose material are usually completely timbered, though if the clay be compact it may not be necessary to line the floor. This timbering may consist of sets with plank lagging, or may be made only of planks. In the latter case, spreaders are used on the floor and roof boards, similar to those of the caps and sills of sets. The French made some use of sets made of reinforced concrete, but generally only for entrances to dugouts in the rear positions. They are too heavy to transport into the mine workings at the front.

Many of the German mine galleries are of larger dimensions tnan those of the British, and usually are timbered throughout, no matter what the character of the formation. All of the timbering is very substantial and the workmanship is very neat. As a consequence of this policy the Germans were not able to drive their galleries as rapidly as did the British.

TRANSPORTATION AND HOISTING OF SPOIL.

Much of the mining was done under conditions where the spoil was dragged to the mine entry in sandbags.[19] Wherever possible, however, small mine cars were used for this purpose. On account of the noise the mine cars are often run on wooden tracks. In some instances the wheels were rubber-tired. All spoil is placed in sandbags at the face. Most of the hoisting in the British mining was done by hand and much of it by simple windlass or even block pulley. The following data regarding speed of hoisting was obtained from the British. In a shaft, not over 35 feet deep, one man with a 6-inch drum and 14-inch handle can hoist two bags of spoil in about half a minute. Two men with a 12-inch drum can hoist two bags at the rate of 80 to 100 feet per minute. It has been found that a two-man windlass can be operated so as to hoist the spoil from galleries driven at an average of about 30 feet a day, if the depth does not exceed 100 feet.

Small-geared winches are used where the conditions permit. These are used on inclines with small cars running on light rails. The cars have flanged wheels running on about a 40-centimeter track and are built with platform with a shelf at the lower end. The capacity of a two-man winch, geared 5 to 10, 10-inch drum, 14-inch handles, and a car holding 24 bags at 80-foot depth and 250-foot haulage will be about 1,500 bags a day. This equipment should clear about 20 feet of heading a day.

In many instances the only hoisting equipment at hand was the simple block pulley. Experience has shown that two men with a block pulley can hoist an average of one sandbag every three minutes out of a 60-foot shaft. This block pulley has the advantage of hoisting out of an incline in that no special cover has to be provided for the men. To protect the men at the winch a station is put in near the top of the incline, with at least 20 feet of overhead cover. From the stations the bags are hauled to the surface with block pulleys. In their second-line positions the French made considerable use of belt conveyors for excavating spoil from dugouts. So far as known these machines were not used in mining operations.

Practically all of the spoil is carried from the mouth of the shaft or incline to the dump on men's backs. In exceptional cases small handcars are used.

---

[19] Sandbags measure from 12 to 14 by 25 to 33 inches. When filled with earth they weigh from 50 to 70 pounds.

HISTORICAL SKETCH
OF THE CORPS OF ENGINEERS
U. S. ARMY

Number 71, Occasional Papers
The Engineer School, United States Army
July 1939

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1939

War Department,
Office of the Chief of Engineers,
Washington, October 20, 1939.

Approved for publication:

J. L. Schley,
Major General,
Chief of Engineers.

DEPOSITED BY THE
UNITED STATES OF AMERICA
JAN 17 '40

FOREWORD

In 1904 while Commandant of the Engineer School at Washington Barracks, now The Army War College, Washington, D. C., my attention was attracted to the fact that there was no consolidated record available of the services of the Corps of Engineers in peace and war. In other words there was no satisfactory, even brief history of the corps covering the century of its existence since organized in 1802 and stationed at West Point to constitute a military academy, during which period its services had been of such character that the designation of "Army Engineer" had become second in public estimation only to that of "West Pointer."

Much information was readily available in respect to the most outstanding services of some individual members of the Corps and of some events in its long record of achievement. With such material as a basis the compilation of a history was undertaken. It soon became evident, however, that the material at hand was only a small part of that needed to do adequate justice to the services of the corps.

Enough was known of Bushnell, the engineer of the Revolution, who built and operated the first submarine; of L'Enfant, also of the Revolutionary engineers, who under the direction of General Washington laid out the capital city of Washington; of Thayer, an early graduate, who started the Military Academy along the path it has since followed; of Lee, whose services on Scott's staff in Mexico had not been fully recorded, and of the brilliant and able services of many officers who held high command on both sides during the Civil War, to furnish the basis for such a narrative. However, the record of service in war of officers of a staff corps is largely absorbed in the record of the officers under whose command they served. Something is known of Lee's brilliant service as Scott's staff officer in Mexico, but there is little available on the surface of the records regarding the confidential relations existing between Comstock and General Grant from 1863 to 1865, and particularly during the Virginia campaign of 1864, while the former was attached to Grant's staff. Such is the case also as to the staff service of the great majority of our officers notwithstanding their faithful and gallant devotion to duty and the great influence they exerted upon the conduct of campaigns.

Moreover, much attention was needed to the civil duties of the engineer department and the corps upon which is based their well-deserved reputation with the public and with Congress through many years to the present time without a break.

When the situation became clearly apparent, the writing of a history was necessarily suspended. Efforts were then carried forward to gather together, first, a complete roster of all officers who served as engineers in our Armies from the Revolution onward, with references to all available sources of information; and second, information regarding the records of these officers. The revolutionary period offers special difficulties by reason of the scanty and scattered condition of its records.

This research had made some progress but was far from complete when the writer was detached from the school at the end of his tour of duty in 1906. Subsequently he made some effort to continue personally the research but the pressure of other duty brought about its discontinuance and it since has not been resumed. The mass of material collected is partially, but not wholly, embodied in the paper which follows.

Through the desire of the Chief of Engineers to make the results of the research available to future historians, and in the hope that it may be of some value for the purpose, the writer has consented with reluctance to its publication in its present incomplete form. The permanent recording of the history of the Corps of Engineers is merited, not only by the glorious record of its achievements, but in order that its officers may become familiar with these achievements as inspiration for their future efforts.

EDWARD BURR,
Brigadier General, U. S. Army, Retired.

Washington, D. C., *June, 1939.*

HISTORICAL SKETCH OF THE CORPS OF ENGINEERS, UNITED STATES ARMY, 1775-1865

By Maj. EDWARD BURR, *Corps of Engineers, United States Army*

INTRODUCTION

In his History of the War Department Ingersoll opens the chapter upon the Corps of Engineers with this paragraph:

> The Corps of Engineers may be described as the oldest and steadiest branch of the Military Establishment of the United States. Originating at the beginning of the Revolutionary War, it performed valuable services throughout that contest. Early organized under the Government of the Constitution, it has been almost constantly cared for with kindly regard by the Government, and has been less assailed, I think, by demogogues than any other portion of the Army or of the Military Establishment. It is about the only part of the Establishment which has been permitted to enjoy peace, as well during peace as during war.

If the facts outlined below do not justify this opinion, the failure must be attributed to the circumstances and manner of their setting forth and not to the facts themselves.

Having its beginning in the very first days of the Revolution, in the authorization by the Continental Congress of a few officers for each army or department, the Corps of Engineers was slowly increased under the watchful solicitude of General Washington until at the end of the war it probably had a greater number of officers and certainly had a larger enlisted force than was again allowed to it until the opening of the Civil War, nearly a century later, although two important wars had been fought in this period. With the disbanding of the Continental forces after the close of the Revolution, the Corps of Engineers was mustered out of the service in November 1783 and did not reappear as such for nearly 20 years.

In 1794 Congress authorized the raising of a mixed corps of artillerists and engineers, consisting of four battalions of four companies each, and increased this corps in 1798 by the addition of another regiment of three battalions. In 1799 the second regiment was increased by a fourth battalion which was to be raised only in case of war.

This composite corps failed of its purpose, at least so far as concerned the engineers, and, although some instruction of officers and cadets was attempted in the organization stationed at West Point, the measures provided for training officers for the technical work of that corps gave no practical results of value. The necessity for a betterment of these conditions was recognized as early as 1800 and was met by sections 26, 27, and 28 of the act of March 16, 1802, under which act the President was authorized to organize a corps of engineers that was to be stationed at West Point and to "constitute a Military Academy." In this act of 1802 is found, therefore, the genesis of these two institutions which have continued through many vicissitudes, but with an unbroken history, to the present day, and have been of inestimable value to the country in peace as well as in war.

The history of a corps like the Engineers cannot be written upon the same plane as that of a regiment or other similar organization formed of a group of men serving as a whole or in considerable detachment. The Corps of Engineers has at various times included organizations of enlisted men, officered by all or a part of the commissioned strength of the corps, and since 1846 such organizations have existed continuously. The services of these organizations have, however, been but a small part of the services rendered by the corps, and the record of the corps as a whole is largely made up of the individual records of the officers who have held commissions in it during the century and more of its existence. The personal element must, therefore, enter largely into such a historical sketch as follows, and the circumstances of the case constitute a sufficient apology for numerous personal references, if any apology is necessary.

A history of the Corps of Engineers must include also the Corps of Topographical Engineers, whose personnel, duties, and records were absorbed by the former in 1863 after a separate existence of 50 years, during a portion of which period it had been subject to the supervision of the Chief of the Corps of Engineers.

Neither of the two corps was formerly recognized as such prior to the early part of the last century, and neither has a continuous record from the revolutionary period. Both were, however, represented in the Continental Army, and this sketch has been extended to include the records of our military engineers and topographers since the beginning of the Revolution.

The various military engineering functions of the Army and the numerous civil public works that are subject to the control of the Secretary of War have as a general rule been placed under the supervision of the Chief of Engineers, United States Army, together with many other civil public duties of a technical character that have been assigned directly to his charge by Congress. The office of the Chief of Engineers for the discharge of these duties constitutes the Engineer Department, United States Army—a Bureau of the War Department. The peace duties of the officers of the corps have had to do largely with the execution of public works, both military and civil, under the direction of the Engineer Department, and the history of that department covers much of the peace record of the corps.

The author is not a pioneer in the field covered by this sketch and desires to acknowledge his indebtedness to all who have preceded him. Free use has been made of the results of their labors, to the extent in many instances of transferring bodily liberal extracts without giving specific credit therefor, and what follows should be considered in the light of this acknowledgment.

THE ENGINEERS DURING THE REVOLUTION

Upon the breaking out of the War of the Revolution the Colonies were singularly deficient in persons acquainted with the duties of military engineers. With the exception of a few men who had seen service at Louisburg, Lake George, Ticonderoga, Crown Point, or Quebec, and had thus gained some practical experience in the construction, attack, and defense of fortified places, there was scarcely any military engineering skill or talent in the Colonies. Nevertheless, the importance of the engineer branch of the service and the need of technically trained officers obtained early recognition, and the Continental Congress made in June 1775 the first legislative provision for engineers for the Continental Army.

The earliest records relative to what is now known as the Corps of Engineers must therefore be sought among the incomplete documents that have come down to us from the period of the Revolution. The records of the Continental Army are most incomplete, but the journals of the Continental Congress indicate the gradual development of this branch of the service under the peculiar conditions existing at that period.

On June 16, 1775, the day before the battle of Bunker Hill, the Continental Congress—

> *Resolved,* That there be one Chief Engineer at the Grand Army, and that his pay be $60 per month.
>
> That two assistants be employed under him, and that the pay of each of them be $20 per month.
>
> That there be one Chief Engineer for the Army in a separate department and two assistants under him; that the pay of the Chief Engineer be $60 per month and the pay of his assistants each $20 per month.

The pay given above to the Office of Chief Engineer and Assistant Engineer was the compensation which attached at that time to the grades of colonel and captain, respectively, and the officers appointed in the Army under this resolution were commissioned with the ranks named. This practice continued for the first year of the war, but by April 1776 assistant engineers were commissioned with as high rank as lieutenant colonel in the continental establishment. Richard Gridley was appointed colonel and Chief Engineer in June 1775 and held the office until August 5, 1776, when he was succeeded by Rufus Putnam, a brother of the famous revolutionary general of the same name. Putnam was transferred to the Massachusetts line November 1, 1776.

On January 16, 1776, it was resolved "That if General Washington think proper Col. R. Gridley be continued Chief Engineer in the Army at Cambridge."

These meager authorities failed to meet the needs of the Army and Washington's correspondence is filled with complaints of the imperfect qualifications and the paucity of engineers in his forces. To Congress he wrote on July 10, 1775, of his lack of engineers to direct the defenses of Boston, "the skill of those we have being very imperfect"; to Governor Trumbull he said, November 2, 1775, "I sincerely wish this camp could furnish a good engineer"; and to the committee of safety of Pennsylvania, which had applied to him for an engineer to erect a redoubt at Billingsport, he replied, June 17, 1776, "I have but one on whose judgment I should wish to depend in laying out any work of the least consequence. Congress well know my wants in this instance and several of my late letters to them have pressed the appointment of gentlemen qualified for the business."

The effect of Washington's correspondence with Congress may be found in the authority granted him to raise, in addition to other troops, "a Corps of Engineers," by the following action of December 27, 1776:

> *Resolved*, That General Washington shall be, and he is hereby, vested with full, ample, and complete powers to raise and collect together, in the most speedy and effectual manner, from any or all of these United States, sixteen battalions of infantry, in addition to those already voted by Congress; to appoint officers for the said battalions of infantry; to raise, officer, and equip three thousand light-horse, three regiments of artillery, and a Corps of Engineers, and to establish their pay. * * * That the foregoing powers be vested in General Washington for and during the term of six months from the date hereof, unless sooner determined by Congress.

It is probable that under this law some organization styled a "Corps of Engineers" was established in the Army under the rules and regulations of General Washington, but, in the absence of trained military engineers in the Colonies, most of those employed proved to be common surveyors with a modicum of scientific knowledge, or adventurers professing to have been educated in foreign military schools, or incompetent charlatans. Legislation alone, without preparation in advance of national need, failed to produce competent officers, as has unfortunately been proven many times since the Revolution, and Congress at last, through our commissioners at Paris—Dr. Franklin and Silas Deane—was compelled to ask the King of France for engineers; for, said the sarcastic Gen. Charles Lee, "we had not an officer who knew the difference between a chevaux-de-frise and a cabbage garden."

The efforts of our diplomatic agents abroad, together with the news of the conflict of the Colonies with Great Britain, brought many foreign officers to our shores. On July 8, 1777, Congress resolved "That the treaty made by the commissioners in France on the 13th day of February last be confirmed as far as it respects the Chevalier du Portail, Monsieur de la Radiere, and Monsieur du Gouvion; the first to be a colonel, the second a lieutenant colonel, and the third a major of engineers." These officers were from the royal corps of engineers of the French Army. Louis le Bégue du Portail took precedence over all other engineers in the Continental Army. He became Chief Engineer July 22, 1777, and served as such to the close of the war. having been promoted to be brigadier general November 17, 1777, and major general November 16, 1781. Other foreign officers who had been educated as military engineers were commissioned as such and assigned to the various armies and commands as needed.

The propriety of establishing by law a Corps of Engineers in the Army and the inadequacy of the organization authorized to General Washington in 1776 attracted the attention of Congress, and on March 6, 1778, a letter, dated the third of the same month, was received in Congress from a committee in camp, inclosing a plan for the establishment of a Corps of Engineers. Action on the matter was not, however, taken at that time, but on May 27, 1778, the needs of the service were partially met when Congress—

> *Resolved*, That in the Engineering Department three companies be established, each to consist of—
>
> | | Pay per month |
> |---|---|
> | 1 captain | $50.00 |
> | 3 lieutenants, each | 33.33⅓ |
> | 4 sergeants, each | 10.00 |
> | 4 corporals, each | 9.00 |
> | 60 privates, each | 8.33⅓ |
>
> These companies to be instructed in the fabrication of field works, as far as relates to the manual and mechanical part. Their business shall be to instruct the fatigue parties to do their duty with celerity and exactness, to repair injuries done to the works by the enemy's fire, and to prosecute works in the face of it.
>
> The commissioned officers to be skilled in the necessary branches of mathematics; the noncommisioned officers to write a good hand.

These sappers and miners were the first companies of engineer troops organized in our service; and, although the law for the creation of a Corps of Engineers was still delayed, the fact that at this time the engineers in the service must have had some organization in the form of a corps is apparent from the resolution of April 18, 1778, as follows:

> *Resolved*, That General Washington be authorized and directed forthwith to convene a council, to consist of the major generals in the State of Pennsylvania and the general officer commanding the Corps of Engineers, and with the advice of the said council to form such a plan for the general operations of the campaign as he shall deem consistent with the welfare of these States.

And also from the resolution of June 13, 1778, namely:

> *Resolved*, That Monsieur du Cambray be annexed to the Corps of Engineers commanded by Brigadier Du Portail, with the rank and pay of a lieutenant colonel.

On the 11th of March 1779 the following resolutions constituting a Corps of Engineers were passed in Congress:

> *Resolved*, That the engineers in the service of the United States shall be formed in a corps and styled the "Corps of Engineers" and shall take rank and enjoy the same rights, honors, and privileges with the other troops in the continental establishment.
>
> That a commandant of the Corps of Engineers shall be appointed by Congress, to whom their orders or those of the Commander in Chief shall be addressed, and such commandant shall render to the Commander in Chief and to the Board of War an account of every matter relative to his department.
>
> That the engineers shall rank in their own corps according to the dates of their respective commissions.
>
> That every year, previous to the opening of the campaign, the commandant of the corps shall propose to the Commander in Chief and to the Board of War such a disposition of the engineers as he shall judge most advantageous, according to the knowledge which he is supposed to have of their talents and capacity.
>
> *Resolved*, That the Board of War be empowered and directed to form such regulations for the Corps of Engineers and companies of sappers and miners as they judge most conducive to the public service and that the Board report such allowances as they judge adequate and reasonable to be made to the officers of the Corps of Engineers for traveling charges, and when on command at a distance from camp or in places where they cannot draw rations.

On the 11th of May following, Du Portail was appointed commandant of the corps by the following resolution of Congress:

> *Resolved*, That the pay and subsistence of the engineers and of the officers and men of the companies of sappers and miners shall be the same with those of officers of the like rank and of the men in the artillery of these States.
>
> That Brigadier General Du Portail be appointed commandant of the Corps of Engineers and companies of sappers and miners.

Under the operations of these laws the Corps of Engineers, with its companies of sappers and miners, served in the armies during the War of the Revolution with efficiency and distinction, and numbers of its officers were brevetted by Congress for their distinguished services. The commandant of the corps was especially rewarded, as appears from the resolution of November 16, 1781, as follows:

> *Resolved*, That Brigadier General Du Portail, commanding officer of the Corps of Engineers, in consideration of his meritorious services, and particularly of his distinguished conduct in the siege of York, in the State of Virginia, be, and he is hereby, promoted to the rank of major general.

It is difficult to enumerate the officers composing the Corps of Engineers in the Army of the Revolution; but it is believed that it did not contain, outside of the companies of sappers and miners, any officer of a lower grade than captain. The names of 1 brigadier general and commandant of the corps, of 6 colonels, of 8 lieutenant colonels, of 3 majors, and of 10 captains have been recovered. There is no question but that the corps was larger than the numbers given above.

Among its officers, besides Du Portail, were Thaddeus Kosciusko, David Bushnell, whose application of submarine boats to warfare was a century and more ahead of his time, and Peter Charles l'Enfant, whose plans for the new Capital of the Republic are appreciated even more highly now than they were a century ago and are a model of municipal development for all time. Foreign officers largely predominated in the Corps of Engineers of the Continental Army and subsequently, owing to the lack of trained engineers among our native officers. Their services were most timely and were highly appreciated, and for many years this foreign influence preponderated in the service.

In November of 1783 this Corps of Engineers and its companies of sappers and miners were disbanded and mustered out of service, having agreed to accept the commutation of 5 years' pay in lieu of the half pay for life; and, while many of the foreign officers returned to their homes in Europe, a number remained in the United States and became citizens of the country.

THE POST-REVOLUTIONARY PERIOD

During the period which elapsed between the close of the War of the Revolution and the inauguration of the Government under the Constitution in 1789 no exigency arose which required the employment of military engineers.

As early, however, as 1789, in the plan submitted by the Secretary of War, Gen. Henry Knox, to the President for the general arrangement of the military forces of the country, there was recommended, as a part of the Military Establishment of the United States, "a small corps of well-disciplined and well-informed artillerists and engineers."

Under the pressure of the relations existing between this country and the principal European countries, and the message of President Washington of December 3, 1793, Congress, on the 20th of March 1794, authorized the President to fortify certain harbors along the coast, and the next day appropriated funds for the work. There were no engineers in the Army to carry on these works, and the President, therefore, directed the temporary appointment of a number of engineers to design and superintend their construction, dividing the coast into districts and appointing one or more engineers for each district.

The gentlemen appointed to these positions were foreign-born, and a number of them had been in the Corps of Engineers of the Revolutionary Army. Among them were Stephen Rochefontaine, Charles Vincent, Peter Charles l'Enfant, John Jacob Ulrich Rivardi, John Vermonet, Nicholas Francis Martinon, and Paul Hyacinte Perrault, who were appointed for and entered upon the discharge of this duty between March 25 and May 12 of 1794.

The need for engineers brought about in 1794 the acceptance of General Knox's recommendations, and by the act of May 9, 1794, Congress provided for raising and organizing, for a term of 3 years, a Corps of Artillerists and Engineers, to be incorporated with the Corps of Artillery in service, the entire number to consist of 992 rank and file.

The organization prescribed was as follows:

One lieutenant colonel commandant, 1 adjutant, and 1 surgeon. Four battalions, with 4 majors, 4 adjutants and paymasters, and 4 surgeon's mates. Sixteen companies, each to consist of 1 captain, 2 lieutenants, 2 cadets, 4 sergeants, 4 corporals, 42 privates (sappers and miners), 10 artificers, and 2 musicians.

The Secretary of War was to provide the necessary books, instruments, and apparatus for the use and benefit of the corps, and the President was authorized to employ such proportions of said corps in the field, on the frontiers, or in the fortification of the sea coasts, as he might deem consistent with the public service.

The organization of the corps was at once commenced and was completed by the spring of 1795. Stephen Rochefontaine was appointed the lieutenant colonel and commandant and Henry Burbeck, Louis Tousard, J. J. U. Rivardi, and Constant Freeman the majors. It will be seen from this list that several of the engineers temporarily engaged upon the fortification of the coast were commissioned in the Corps of Artillerists and Engineers, and as long as this corps existed there were always a number of its officers engaged exclusively upon the construction and repair of the seacoast works. Some of the companies were in garrison in the fortifications, but the main body was stationed at West Point, where at the same time a military school was organized. The books and apparatus of the school were burned in 1796, and it was suspended until 1801, when, under the direction of Maj. Jonathan Williams, of the Second Regiment of the Corps of Artillerists and Engineers, the school was revived and, upon the organization of the Corps of Engineers in 1802, was continued as the Military Academy.

By the act of March 3, 1795, the Corps of Artillerists and Engineers, originally authorized for 3 years only, was continued indefinitely and its completion authorized. The act of May 30, 1796, to ascertain and fix the Military Establishment of the United States, provided that the Corps of Artillerists and Engineers should form a part of that establishment and should be completed in conformity with the act of 1794.

Laincourt, who visited West Point in 1796, states that he found at that place four battalions of artillerists and engineers, composed of about 250 men each, mostly made up of foreigners. But 10 officers were present, representing "all nations."

Our relations with France continuing to be threatening, a second regiment of artillerists and engineers was authorized by the act of April 27, 1798. By its terms the regiment was to consist of—

One lieutenant colonel commandant, 1 adjutant, and 1 surgeon. Three battalions, with 3 majors, 3 adjutants and paymasters, and 3 surgeon's mates. Twelve companies, each to consist of 1 captain, 2 lieutenants, 2 cadets, 4 sergeants, 4 corporals, 42 privates (sappers and miners) 10 artificers, and 2 musicians.

It was placed upon precisely the same footing as the first regiment raised and wàs to be supplied with the same books and apparatus and to do duty at the same places and times as were prescribed for the former.

The officers were appointed to rank from June 1, 1798. John Doughty was appointed the lieutenant-colonel and commandant of the regiment and Benjamin Brooks, Adam Hoops, and Daniel Jackson the majors.

By the act of July 16, 1798, to augment the Army of the United States, the President was authorized to appoint a number not exceeding four teachers of the arts and sciences, necessary for the instruction of the artillerists and engineers.

The recommendations leading to the above legislation will be found in an extract of a letter from the Secretary of War, James McHenry, to the Hon. Samuel Sewell, chairman of the committee of defense, etc., dated War Department, June 28, 1798, as follows:

> Third. The act providing for raising and organizing a corps of artillerists and engineers and the act to provide an additional regiment of the same, both enjoin the procurement at the public expense of all necessary books, instruments, and apparatus, for the benefit of the said respective regiments.
>
> The Secretary, without designing to derogate from the merits of the officers appointed to the corps established by the acts cited, feels it his duty to suggest that other and supplementary means of instruction to the books and instruments to be provided, appear to be absolutely indispensable to enable them to acquire a due degree of knowledge in the objects of their corps. It is certain that the best faculties and inclinations for the arts and sciences cannot be unfolded, and applied to useful purposes, when proper encouragement and assistance have been denied or neglected.
>
> The art of fortification is connected with so many others, is of such extent, and its operations dependent on, and affected by circumstances so infinitely varied, that it is impossible any man can be rendered master of it by experience alone. Besides, the knowledge acquired by experience is often the results of our own faults, and acquired by a heavy, and it may be, in this art, disastrous expense to the public.
>
> It is certainly to be wished that more attention had been paid to this subject, and that past recommendations had found a favorable access to the ear of Congress.
>
> If the present moment does not admit of carrying into effect all that is desirable, and ought, under different circumstances, to be done, to create a body of qualified and scientific engineers, it may, notwithstanding, be advisable to advance towards this point by such measures as are compatible with our present situation.

* * * * * * *

> It is therefore submitted whether provision ought not to be made for the employment of three or four teachers of the enumerated sciences, to be attached generally to the two Corps of Artillerists and Engineers, and obligated to give instruction and lessons at such times, places, and under such regulations as the President may direct.
>
> The employment of teachers would give the intended effect to the provision of the laws for the appointment of two cadets to each company. It was supposed that these cadets would form a nursery, from which qualified officers might be drawn to fill vacancies, but it must occur, that without proper masters to teach them the sciences necessary to the engineers and artillerists, this nursery can produce no valuable plants.

In a paper upon the proper changes that should be made in the Military Establishment, written by the Secretary of War, James McHenry, and dated December 24, 1798, after recommending that the organization of the Second Regiment of Artillerists and Engineers should be made the same as that of the First Regiment, he says:

> It is deeply to be lamented that a very precious period of leisure was not improved toward forming among ourselves engineers and artillerists, and that, owing to this neglect, we are in danger of being overtaken by war without a competent number of characters of these descriptions. To form them suddenly is impracticable; much previous study and experiment are essential. If possible to avoid it, a war ought not to find us unprovided. * * *
>
> In the meanwhile, it is conceived to be advisable to endeavor to introduce from abroad at least one distinguished engineer, and one distinguished officer of artillery. They may be sought for preferably in the Austrian, and next in the Prussian armies. The grade of colonel, with adequate pecuniary compensations, may attract officers of a rank inferior to that grade in those Armies, who will be of distinguished abilities and merit. But in this, as we know from past experience, nothing is more easy than to be imposed upon, nothing more difficult than to avoid imposition, and that, therefore, should the measure be sanctioned by a law, it will be requisite to commit the business of procuring such characters to some very judicious hand, under every precaution that can be put him on his guard.
>
> It is also suggested that an inspector of fortifications is much wanted. In case of a legislative provision on this subject, the officer may either be drawn from the Corps of Artillerists and Engineers, or it may be left discretionary with the President to choose him where he pleases.

By the act of March 2, 1799, to augment the Army, an additional battalion of artillerists and engineers was authorized, bringing the Second Regiment of Artillerists and Engineers to the same strength as the First Regiment. This battalion was, however, to be raised only in case of foreign war and was never organized.

By the act of March 3, 1799, for the better organization of the troops of the United States, the President was authorized to engage and appoint, distinct from the officers of the Corps of Artillerists and Engineers, two engineers with the rank of lieutenant colonel, and to stipulate and allow them, respectively, such compensation as he shall find necessary and expedient.

This act also provided for the appointment of an inspector of fortifications, whose duties were to be assigned him by the Secretary of War, under the direction of the President. He was to be taken from the Corps of Artillerists and Engineers, or other corps, and if not an officer in the artillery or Army, he was to be entitled to the rank of major in the Army.

It is not known whether the two officers of engineers, distinct from the Corps of Artillerists and Engineers, with the grade of lieutenant colonel, were ever appointed; it is probable they were not. Nevertheless, in the act of May 14, 1800, to discharge the officers and men raised under the acts of March 2 and 3, 1799, it was provided that the engineers, the inspector of artillery, the inspector of fortifications, and the two regiments of artillerists and engineers should be retained in service without reduction in numbers.

THE ORGANIZATION OF THE CORPS OF ENGINEERS AND THE MILITARY ACADEMY

The authorization and organization of the Corps of Artillerists and Engineers was but a partial and temporary revival of the Corps of Engineers as it existed during the Revolutionary War. This composite organization passed out of existence under the act of March 16, 1802, which determined and reduced materially the Military Establishment. From it were created by the same act two organizations—the Corps of Engineers and a Regiment of Artillery. The following remarks of Secretary McHenry, precedent to the above legislation, will be found of interest in this connection. They are extracted from a report made by him to the President, on the 5th of January 1800 upon the subject of the Military Academy and the reorganization of the Army:

> It is conceived that the entire union of the officers of artillerists and engineers in one corps, as in our present establishment, is not advisable. The art of fortification and the service of artillery, though touching each other in many points, are in the main distinct branches, and each so comprehensive that their separation is essential to perfection in either. This has been ascertained by long experience. Among the powers of Europe there is not one recollected, which at the present day, is not conscious of this truth. When any of them have attempted to unite these corps, the disadvantages which resulted were soon felt to be so momentous, as to produce conviction that each required a separate organization. Such a union was once attempted in France. According to an ordinance of the 8th of December 1755 the artillery and engineer corps of that Nation, which had been separate, were combined in one. The experiment, however, was of short duration. In 1758, the Engineer Corps was disjoined from the Corps of Artillery, and called as before, the Corps of Engineers, since which time these corps have remained separate.

The recommendations of Secretary McHenry with reference to the revival of the Corps of Engineers, contained in the same report, are as follows:

> The Regiment of Engineers consisting entirely of officers, if we exclude the companies of miners, it remains to speak of its organization. Let it consist of, viz, two lieutenant colonels, one first and one second, as already provided by law; three majors, twelve captains, twenty-four first lieutenants, twenty-four second lieutenants, twenty-four cadets.
>
> The companies of miners, and their labors, to be under the direction and immediate command of officers of this corps, and to make a part thereof.
>
> It will be perceived, and it is observed with regret, that the Engineer Regiment cannot be immediately formed by the mere act of transferring into it officers from any of the existing regiments. In order to answer its high destination it must be filled slowly, and under the exercise of great caution and responsibility.

In another communication, dated January 31, 1800, Secretary McHenry says concerning the Military Academy, and the proposed revival of the Corps of Engineers:

> A slight attention to circumstances and the actual position of our country, must lead to the conviction, that a well-connected series of fortifications is an object of the highest importance to the United States, not only as these will be

conducive to the general security, but as a means of lessening the necessity, and, consequently, the expense of a large Military Establishment.

* * * * * * *

We must not conclude from these brief observations, that the service of the engineers is limited to constructing, connecting, consolidating, and keeping in repair fortifications. This is but a single branch of their profession, though, indeed, a most important one. Their utility extends to almost every department of war, and every description of general officers, besides embracing whatever respects public buildings, roads, bridges, canals, and all such works of a civil nature. I consider it, therefore, of vast consequence to the United States, that it should form in its own bosom, and out of its own native materials, men qualified to place the country in a proper posture of defense, to infuse science into our Army, and give to our fortifications that degree of force, connection, and perfection, which can alone counterbalance the superiority of attack over defense.

By the act of March 16, 1802, fixing the peace Military Establishment of the United States, it was enacted:

SEC. 26. That the President of the United States is hereby authorized and empowered, when he shall deem it expedient, to organize and establish a Corps of Engineers, to consist of one engineer, with the pay, rank, and emoluments of a major; two assistant engineers, with the pay, rank, and emoluments of captains; two other assistant engineers, with the pay, rank, and emoluments of first lieutenants; two other assistant engineers, with the pay, rank, and emoluments of second lieutenants; and ten cadets, with the pay of $16 per month, and two rations per day; and the President of the United States is in like manner authorized, when he shall deem it proper, to make such promotions in the said corps, with a view to particular merit and without regard to rank, so as not to exceed one colonel, one lieutenant colonel, two majors, four captains, four first lieutenants, four second lieutenants, and so that the number of the whole corps shall at no time exceed twenty officers and cadets.

SEC. 27. That the said corps, when so organized, shall be stationed at West Point, in the State of New York, and shall constitute a Military Academy; and the engineers, assistant engineers, and cadets of said corps shall be subject at all times to do duty in such places and on such service as the President of the United States shall direct.

SEC. 28. That the Principal Engineer, and, in his absence, the next in rank, shall have the superintendence of the said Military Academy, under the direction of the President of the United States; and the Secretary of War is hereby authorized, at the public expense, under such regulations as shall be directed by the President of the United States, to procure the necessary books, implements, and apparatus for the use and benefit of the said institution.

Under the operations of this act Maj. Jonathan Williams, of the former Second Regiment of Artillerists and Engineers and Inspector of Fortifications, was appointed major, Corps of Engineers, and Principal Engineer, and on April 13, 1802, he became the first superintendent of the Military Academy. William Amherst Barron and Jared Mansfield were appointed captains. The former on April 13, 1802, became the teacher in mathematics and the latter on May 3, 1802, the teacher in natural and experimental philosophy. Peter Anthony Dransey and James Wilson were appointed first lieutenants, the former declining the appointment, and Joseph Gardner Swift, Simon M. Levy, and Walker Keith Armistead were appointed cadets.

This was the beginning of the present Corps of Engineers, and of the Military Academy at West Point. To quote the words of Major Williams—

A part only of the officers were appointed soon after the passage of the act, of whom the major, who was *ex officio* the Chief Engineer, and two captains, took charge of the academy, the students of which were the cadets belonging to the regiment of artillery. The major occasionally read lectures on fortifications, gave practical lessons in the field, and taught the use of instruments generally.

> The two captains taught mathematics; the one in the line of geometrical, the other in that of algebraical demonstration.

From its very organization some commissioned officers of the corps were engaged upon the fortifications of the coast, and the majority of those who acted the part of teachers, during the first 2 or 3 years of the existence of the academy, were soon replaced by teachers and professors appointed to instruct in special subjects. By February of 1808 but one officer of the corps remained at the Military Academy, serving in the capacity of acting superintendent, and also as instructor of certain branches. In the words of Colonel Williams—

> It was not probably foreseen, that although the headquarters of the corps might be at West Point, yet the duties of the individual officers necessarily spread them along our coast from one extremity of the United States to the other, and, as the whole number of officers can be no more than sixteen, they could not in their dispersed state constitute a Military Academy. The incongruity of a stationary and errant existence of the same corps has been amply exemplified by experience.

It is not proposed to write here a history of the Military Academy or to quote the laws concerning it, although its early history was closely related to that of the Corps of Engineers. It is sufficient to say that the charge and superintendency of the academy remained with the Corps of Engineers until July 13, 1866, when by act of Congress it passed to the Army at large. As to this stewardship Ingersoll, in his History of the War Department, says—

> It is proper here to observe that, from this time until the year after the close of the War of the Rebellion, the Military Academy remained under the charge of the Corps of Engineers. During this period the academy grew from a school of humble pretensions to an institution of the most complete character, furnishing to its cadets as thorough a military education, practically and scientifically, as could be gained at almost any other similar institution in the world. The present efficiency of the academy, everywhere acknowledged, was given to it during the sixty years' control by the Corps of Engineers.

To this commendation of the work of the corps at the academy during the formative period and its first sixty years of usefulness there need only be added that the records of its graduates are the best evidences of the success of the school and from its students of that period West Point not only furnished to the Army military leaders of the highest training and ability but also supplied to the commercial and transportation interests of the country technically trained men at a time when such training was to be had at almost no other school on this continent.

The first enlisted men of the present corps were authorized by the act of February 28, 1803, which provided:

> SEC. 3. That the commanding officer of the Corps of Engineers be authorized to enlist, for a term not less than three years, one artificer and eighteen men, to aid in making practical experiments, and for other purposes, etc., etc.

In the latter part of 1802 there arose the question of the right of engineer officers to command outside of their own branch of the service and upon reference of the matter to the War Department the decision was adverse to the corps. An appeal was made to the President but without result and the two field officers of the corps resigned, Lieutenant Colonel Williams in June 1803 and Major Wadsworth in February 1805.

The controversy was definitely settled by the issuance of General Orders of April 17, 1805, confirming the previous decision and fixing the status of engineer officers as not belonging to the line. By this order, they were to assume command in the line only by special order of the President and the order was given the force of law by the enactment of the Sixty-third Article of War on April 10, 1806. Upon the acceptance by him of the President's conclusions, Colonel Williams was reappointed lieutenant colonel and Chief Engineer, April 19, 1805. A more complete account of this controversy will be found later.

On the 23d of February 1808 the corps was filled by regular promotions to the full numbers authorized by the organic act of March 6, 1802. Jonathan Williams was the colonel and Chief Engineer, Jared Mansfield the lieutenant colonel, and Alexander Macomb and Joseph G. Swift the majors. With the exceptions of Lieutenant Colonel Mansfield, who had been surveyor general of the Northwest Territory since November 1, 1803, with office at Cincinnati, and of Lt. Alden Partridge, who was retained at the Military Academy, all the officers of the corps were spread along the coasts in charge of active operations upon fortifications. The Office of the Chief Engineer was in New York Harbor.

The act of April 29, 1812, increased the number of commissioned officers from 16 to 22 by an increase of 2 each in the grades of captain, first and second lieutenant, and provided the first company of engineer troops in the following provisions:

> SEC. 1. That there be added to the Corps of Engineers two captains; two first lieutenants; two second lieutenants; with the usual pay and emoluments according to their grades respectively; and one paymaster, to be taken from the subalterns of engineers, with the pay and emoluments of a regimental paymaster, and that there be attached to the said corps, either from the troops now in service or by new enlistments, as the President of the United States may direct, four sergeants, four corporals, one teacher of music, four musicians, nineteen artificers, and sixty-two men, which noncommissioned officers, musicians, artificers, and men, together with the artificers and men already belonging to the Corps of Engineers, shall be formed into a company, to be styled a company of bombardiers, sappers, and miners, and be officered from the Corps of Engineers, according as the commanding officer of that corps may, with the approbation of the President of the United States, direct.
>
> SEC. 6. That so much of the twenty-sixth section of the act entitled "An act fixing the military peace establishment," passed the 16th day of March 1802, as confines the selection of the command of the Corps of Engineers to the said corps be, and the same is hereby, repealed.

By section 4 of the same act it was provided—

> That when any cadet[1] shall receive a regular degree from the academical staff, after going through all the classes, he shall be considered as among the candidates for a commission in any corps, according to the duties he may be judged competent to perform; and in case there shall not, at the time, be a vacancy in such corps, he may be attached to it at the discretion of the President of the United States, by brevet of the lowest grade, as a supernumerary officer, with the usual pay and emoluments of such grade until a vacancy shall happen: *Provided*, That there shall not be more than one supernumemary officer to any one company at the same time.

Under the authority of this statute supernumerary officers have been attached at different times to the corps in varying numbers as

brevet second lieutenants in addition to the authorized commissioned strength.

---

[1] Of the U. S. Military Academy.

THE ENGINEERS IN THE WAR OF 1812

War against Great Britain was declared June 15, 1812, and on June 21, Col. Jonathan Williams, Chief Engineer, applied to the President for a command consistent with his rank and services, under the act of 1802 and the Sixty-third Article of War. Prior to May 27, 1812, Colonel Williams received his orders directly from the War Department but on that day he was placed under the orders of Brigadier General Bloomfield to whom had been confided the command of the city and harbor of New York. In his petition he says that "while I cannot assume the command of a subaltern, I am expected to perform professional duty where a subaltern commands" and prays to be relieved from the unpleasant situation and placed "in that which my nominal rank points out and which my honor demands."

On June 23, 1812, General Bloomfield was advised that it was the pleasure of the President that whenever the exigencies of the service required the talents and knowledge of the officers of the Corps of Engineers beyond the line of their immediate profession, he might assign those under his command to such duties in the line of the Army as comported with their rank. General Bloomfield advised Colonel Williams that his request would be granted and verbally communicated to him his orders of assignment to the command of Castle Williams. The issuance of formal orders was delayed by reason of discontent among the artillery officers of the command over Colonel Williams' assignment, this discontent finding expression in a memorial signed by 18 company officers, nearly all of whom were subalterns. The delayed order was formally issued to Colonel Williams on July 10 and on the same day he resigned his commission in the Army, basing it upon his views of his duty to his own rank and his desire to preserve harmony among the officers of the Army, "whose profession, of all others, should form a well connected and affectionate brotherhood," and, he says, "The loss of an officer in his sixty-third year may not be considered of great importance when compared with that of 18 officers in the vigor of youth."

On July 6, 1812, Lt. Col. Alexander Macomb, of the corps, was appointed colonel of the Third Regiment of Artillery and, as a result of the two casualties just mentioned, Joseph G. Swift, the first graduate of the Military Academy, became colonel and Chief Engineer; Walker K. Armistead became lieutenant colonel; George Bomford and William McRee became majors. The corps then consisted of 1 colonel, 1 lieutenant colonel, 2 majors, 6 captains, 6 first lieutenants, 6 second lieutenants, and 1 company of bombardiers, sappers and miners; a total authorized strength of 22 commissioned officers and 113 enlisted men.

The official registers show the names of 25 officers of engineers between 1812 and 1815, of whom 1 (Long) was not appointed until after the close of actual hostilities. Five others saw no service in the field, being on duty at the Military Academy and at points on the coast where no actions took place, and no records are available as to the services of 3 others (lieutenants). The remaining 17 saw service in all the campaigns from Hull's ignominious failure at Detroit in 1812 to Jackson's brilliant victory in 1815.

One served with Hull and 3 on the Niagara Frontier in 1812; 2 with Harrison in the West, 3 in northern New York, and 1 at Niagara in 1813; 4 on the Niagara and 3 on Lake Champlain in 1814; and 3 at Baltimore and Norfolk in 1813–14. One was killed in action, another died as a prisoner of war after Hull's surrender of Detroit and 2 others died in service. Ten were brevetted, 3 of them being brevetted twice.

The Company of Bombardiers, Sappers and Miners, authorized in 1812, was organized at West Point and ordered on June 16, 1814, to join the Army under General Brown on the Niagara frontier. Proceeding to Albany by sloop, the company marched 360 miles in 13 days and reached Buffalo on July 9, 1814. There the company crossed the river without delay and proceeded to join the Army, reaching Chippewa at midnight of the same day and Queenstown the next morning. One-half of the siege train was assigned to the company and fought by it to the end of the campaign under the able command of Lt. David B. Douglass.

The land operations of the war were, as a whole, a series of disasters or of failures to achieve results of value, our armies being on the defensive along our own frontiers during the greater part of every campaign. The causes are now well recognized in the inefficiency of the War Department and in a military policy whose defects and dangers were most markedly illustrated in this war and with regard to which General Upton [2] says that, "Whether we may be willing to admit it or not, in the conduct of war, we have rejected the practice of European nations and with little variation, have thus far pursued the policy of China."

Engineer officers, however, gained distinction wherever distinction was to be gained. The only engineer for duty in Harrison's campaign in the West was brevetted, and the five who served on the Niagara in 1813–14 were all brevetted, as were also the three in the campaign of the same year on Lake Champlain. Most prominent among them, besides the Chief Engineer, Colonel Swift, were Majors McRee and Wood and Captain Totten, all three of whom were twice brevetted. Colonel Swift commanded the brigade garrisoning Staten Island in 1813 and later in the same year was chief engineer to General Wilkinson's army on the St. Lawrence. In 1814 he was Chief Engineer to the forces for the defense of New York, receiving a brevet for his services and being voted by the corporation of New York a "Benefactor of the city."

Wood served with General Harrison in his campaign in the West in 1813, from Fort Meigs to the battle of the Thames, practically as chief engineer, his superior, Gratiot, being incapacitated from sickness. For his services and "undaunted bravery" at Fort Meigs, Wood was awarded by General Harrison in his order of the day "the first palm of merit" and received a brevet. During Harrison's invasion of Canada and the battle of the Thames he had charge of the artillery and again received his general's commendations.

---

[2] The Military Policy of the United States, p. vii.

In the 1814 campaign on the Niagara Frontier, Wood was assigned as assistant to McRee, who was Chief Engineer to Maj. Gen. Jacob Brown, commander in chief, and later to the command of troops. Both of these officers highly distinguished themselves throughout the campaign. In the fiercely fought battle of Niagara (Lundy's Lane), where the army gained one of the few laurels won by it during the war in a stubborn contest against a greatly superior force composed largely of veterans from the Napoleonic wars, McRee and Wood were conspicuous and, with Brig. Gen. Winfield Scott, were the only officers who, for their gallant and meritorious conduct in that sanguinary encounter, were singled out, at that time, for honorable distinction by brevets. In his report of the battle General Brown says, "The engineers, Majors McRee and Wood, were greatly distinguished on this day, and their high military talents exerted with great effect; they were much under my eye and near my person, and to their assistance a great deal is fairly to be ascribed. I most earnestly recommend them as worthy of the highest trust and confidence." General Ripley succeeded to the command upon Brown and Scott's disability from wounds and, being upon the point of retreating across the river into our own territory, was only deterred from so doing by the advice of McRee and Wood. When this proposition again came up, these able officers were again consulted by General Brown, who severely rebuked Ripley and shortly afterwards superseded him with Gen. E. P. Gaines.

McRee and Wood were indefatigable during the seven weeks' siege of Fort Erie that followed Brown's retirement to that work before superior numbers. The Company of Bombardiers under Douglass and Story, was assigned with its battery to the right flank of the line. In the night assault by the British, on August 15, Wood had command on the left flank of the remains of the gallant Twenty-first Infantry, that had carried the British battery on the hill at Lundy's Lane, and on both flanks, where the critical attacks were made, the defense was most gallant and able. In Ripley's report it is said, "Wood had the merit, with the Spartan band, in connection with Captain Towson's artillery, of defeating a vaunting foe of six times his force," and Gaines in 1815 wrote, "Among the many brilliant scenes, which combined to dispel the clouds and light up the darkness of that memorable morning, the defense of the Douglass battery stands rivalled by few, and, according to the number of guns, surpassed by none. The youthful commander of that battery excited my admiration."

In the sortie of September 17, Wood commanded a column composed of 400 regulars and 500 volunteers in the flank attack under General Porter and was killed in contributing largely to what Napier in his "Peninsula War" describes as "the only instance in history where a besieging army was entirely broken up and routed by a single sortie." This brilliant final triumph of our arms, greatly "due to the counsels of Colonel McRee and Major Wood," terminated the campaign of 1814 and the war in that scene of action.

McRee and Wood were both very close to General Brown and General Scott during this campaign. After the close of the war General Brown, then Commander in Chief of the Army, caused to be erected at his own expense at West Point a monument to Wood "as a tribute of my respect for the hero and the man," and he freely stated that

"McRee's industry and talents were the admiration of the whole Army." Scott wrote in later years that in his opinion, and perhaps in that of all the Army, McRee "combined more genius and military science with high courage than any other officer who participated in the War of 1812," and that in 1815 he would have been a general officer had the war continued.

To Totten and his assistants, De Russy and Trescott, were due the defenses that contributed to the defeat of the British at Plattsburg, September 11, 1812, and for their ability, as well as for gallant conduct in the battle itself, all received brevets, being 3 out of only 11 officers who were commended by name in the official report of the battle.

Lt. Col. Alexander Macomb, of the corps, who had been appointed colonel of artillery, July 6, 1812, and brigadier general in 1814, commanded the Army which at Plattsburg defeated a largely superior force. For his services in this victory he received the brevet of major general and, by resolution of November 3, 1814, the thanks of Congress and a gold medal. General Macomb was reappointed Chief Engineer in the reorganization of the Army in 1821 and on May 24, 1828, was promoted to be major general on the death of General Brown. Five days later he became Commander in Chief of the Army and held that office until his death on June 25, 1841.

In the following pages will be found the records of all the Engineer officers who held commissions from 1812 to 1815, and it will be observed that even at that early day they were nearly all graduates of the Military Academy and did credit to their alma mater.

OFFICERS OF THE CORPS OF ENGINEERS IN THE WAR OF 1812

Lt. Col. Alexander Macomb; appointed colonel, Third Regiment of Artillery, July 6, 1812, and brigadier general, January 24, 1814; served on the Niagara frontier in 1813, including the capture of Fort Niagara and Fort George, and under General Wilkinson in the St. Lawrence campaign; upon Wilkinson's recall, April 1814 commanded the Army until General Izard's arrival and upon General Izard's departure, August 29, 1814, to reinforce General Brown at Niagara, remained in command of the Army; with 1,500 regulars and detachments of militia and volunteers, defeated at Plattsburg, September 11, 1814, the British force under General Provost, numbering 14,000 men; brevetted major general, September 11, 1814, for distinguished and gallant conduct at Plattsburg and, by resolution of November 3, 1814, received the thanks of Congress and a gold medal for the same action; reappointed colonel and Chief Engineer, June 1, 1821; major general, May 24, 1828; Commander in Chief of the Army, May 29, 1828.

Colonel and Chief Engineer Joseph G. Swift;[3] Chief Engineer of the Department of New York and in command of brigade garrisoning Staten Island, April 6 to August 14, 1813; Chief Engineer of the Army under command of Major General Wilkinson, in the campaign of 1813 on the St. Lawrence River, being engaged in the battle of Chrystler's Field, U. C., November 11, 1813; Chief Engineer of the forces for the defense of the city and harbor of New York, including Brooklyn and Harlem Heights, 1814–15; brevetted brigadier general, February 19, 1814, for meritorious services. Of his services in the battle of Chrystler's Field, General Wilkinson in his official despatch says, "Colonel Swift took the boldest and most active part of any individual engaged, except Adjutant General Walbach." For his services in 1814–15 the corporation of the city of New York voted him a "Benefactor of the city" and conferred upon him numerous presents.

---

[3] First graduate of the U. S. Military Academy.

Lt. Col. Walker K. Armistead;[4] Chief Engineer to Major General Dearborn on the Niagara frontier in the autumn of 1812 and in the bombardment of Fort Niagara, November 21, 1812; Chief Engineer of the forces for the defense of the mouth of Chesapeake Bay, including Norfolk and Craney Island, in 1813. Colonel McFeeley, in command of Fort Niagara during the bombardment, says in his official despatch regarding fires that were caused by the hot shot of the British—"from the extraordinary vigilance of the officers and men, particularly Major Armistead, of the United States Corps of Engineers, whose indefatigable exertions were extended to all parts of the garrison, the fires were got under without being observed by the enemy." Colonel Armistead's preparations for the defense of Craney Island led to the easy and complete repulse, with severe losses, of the British in their attack in 1813.

Maj. George Bomford;[4] on ordnance duty 1812–15; introduced bomb cannon under the name of "Columbiads"; brevetted lieutenant colonel for meritorious services. His services were invaluable by reason of the fact that he was the only officer well informed in the manufacture of ordnance and ordnance stores.

Maj. William McRee;[4] Chief of Artillery (commanding four companies and siege train) of the Northern Army, under Major General Hampton in the campaign of 1813, and Chief Engineer of the Army on the Niagara frontier, commanded by Major General Brown, *in* the campaign of 1814, participating in the combat of Chateaugay River, U. C., the capture of Fort Erie, the battles of Chippewa and Niagara, and the defense of Fort Erie; brevetted lieutenant colonel, July 25, 1814, for gallant conduct in the battle of Niagara and colonel, August 15, 1814, for distinguished and meritorious services in the defense of Fort Erie. At the age of 26, in the Niagara campaign of 1814, his services were of the most distinguished character. In his official report of September 29, 1814, General Brown says: "Lieutenant Colonel McRee and Lieutenant Colonel Wood, of the Corps of Engineers, having rendered to this Army services the most important, I must seize the opportunity of again mentioning them particularly. On every trying occasion, I have reaped much benefit from their counsel and excellent advice. No two officers could have contributed more to the safety and honor of this Army. Wood, brave, generous, and enterprising, died as he had lived, without a feeling but for the honor of his country and glory of her arms. His name and example will live to guide the soldier in the path of duty as long as true heroism is held in estimation. McRee lives to enjoy the approbation of every virtuous and generous mind and to receive the reward due to his services and high military talents." General Brown in his report upon the battle of Niagara says of McRee and Wood that they "were greatly distinguished on that day, and their high military talents exerted with great effect; they were much under my eye and near my person, and to their assistance a great deal is fairly to be ascribed. I most earnestly recommend them as worthy of the highest trust and confidence." He freely stated, "McRee's industry and talents were the admiration of the whole Army," in which he would probably have been made a brigadier general had the war continued. A distinguished Member of Congress who enjoyed the President's confidence wrote in a personal letter in 1828, upon the death of General Brown, "McRee is spoken of as a prominent candidate for General in Chief," but the hero of another campaign of 1814, also an engineer officer, won the prize. Gen. Winfield Scott, no ordinary judge of soldiers, said of McRee, in a letter dated May 31, 1843, "In my opinion, and perhaps, in that of all the Army, he combined more genius and military science with high courage than any other officer who participated in the War of 1812. I know that this was at least a very general opinion. If the treaty of peace had not prevented, he could, as I also know, have been made a general officer in 1815, and I am confident that he would in the field have illustrated the highest grade."

---

[4] Graduate of the U. S. Military Academy.

Capt. Eleazor D. Wood;[4] in General Harrison's campaign in the Northwest in 1813, including the defense of Fort Meigs, and sortie therefrom, skirmish at Chatham, U. C. (in command of the artillery), and the battle of the Thames; in the campaign on the Niagara frontier in 1814, including the capture of Fort Erie, the battle of Chippewa, the affair of Fort George, the battle of Niagara, the defense of Fort Erie and the sortie therefrom on September 17, 1814, when he was killed in command of and gallantly leading a column of regular and volunteer troops; brevetted major, May 6, 1813, for distinguished services in the defense of Fort Meigs and lieutenant colonel, July 25, 1814, for gallant conduct in the battle of Niagara. In General Harrison's campaign of 1813, Wood was virtually chief engineer, Gratiot being most of the time absent on other duty or too sick for active service. General Harrison in his official despatch says: "Captain Gratiot having been for a long time much indisposed, the task of fortifying the post devolved on Captain Wood. It could not have been placed in better hands. Permit me to recommend him to the President, and to assure you that any mark of his approbation bestowed on Captain Wood would be highly gratifying to the whole of the troops who witnessed his arduous exertions." In his order of the day of May 9, 1812, to his command upon the withdrawal of the British from before Fort Meigs, General Harrison says: "From the long illness of Captain Gratiot, of the Corps of Engineers, the arduous and important duties of fortifying the camp devolved upon Captain Wood, of that corps. In assigning to him the first palm of merit, as far as relates to the transactions within the works, the general is convinced his decision will be awarded by every individual in the camp who witnessed his indefatigable exertions, his consummate skill in providing for the safety of every point, and in foiling any attempt of the enemy, and his undaunted bravery in the performance of his duty in the most exposed situations." He was again highly distinguished in the battle of the Thames. In the Niagara campaign of 1814, as assistant to McRee, chief engineer for General Brown, and in command of troops of the line, Wood was unexcelled, meeting his death at the head of his troops, and in the words of General Brown's official report, "His name and example will live to guide the soldier in the path of duty as long as true heroism is held in estimation." Commendations of Wood's services in 1814 are often linked with McRee's in official reports and have been quoted above in connection with the latter. Gaines says in his report of the British assault on Fort Erie, August 15, 1814: "Major Wood, of the Engineers, also greatly contributed to. the previous measures of defense. He has accepted the command of a regiment of infantry (the Twenty-first), for which he has proved himself well qualified, but never so conspicuously as on this occasion." Ripley, on the same occasion, says of Wood, who commanded a flank detachment of 250 men, that beat back a greatly superior force in the critical assault, after five attacks, "To Major Wood I feel particularly indebted. This officer's merits are so well known, that approbation can scarcely add to his reputation. He has the merit, with the Spartan band, in connection with Captain Towson's artillery, of defeating a vaunting foe of six times his force." Porter, under whom he led a column of 400 regulars and 500 volunteers in the sortie of September 17, says, "You know how exalted an opinion I have always entertained of Lieutenant Colonel Wood of the Engineers. His conduct on this day was what it uniformly has been, on every similar occasion, an exhibition of military skill, acute judgment, and heroic valor."

---

[4] Graduate of the U. S. Military Academy.

On September 12, 1816, 2 years after Wood's death, General Brown, then Commander in Chief of the Army, wrote as follows to General Swift, Chief Engineer, regarding the monument afterwards erected at West Point:

> I think it proper to express to you, as Chief of the Corps of Engineers, the high sense I entertain of the services of Colonel McRee, Lieutenant Colonel Wood, Captain Douglass, and Lieutenant Story, who served with my division upon the Niagara in 1814. They were all greatly distinguished, but Colonel McRee and Lieutenant Colonel Wood have particular claims upon me for the cheerfulness and ardor with which they entered upon the the execution of every enterprise, having in view the honor of my command, and for the zeal and talent they uniformly displayed.
>
> Lieutenant Colonel Wood fell! The occasion and manner of his death secure to him the patriot soldier's best reward—pure and imperishable fame. To this I can add nothing; but, as a tribute of my respect for the hero and the man, I request you to cause a monument to be erected, at my expense, to his memory. Let it stand near the Military Academy, at West Point, and, though it cannot elevate his name, it may stimulate the soldiers of his school to die, like him, without a feeling but for the honor of their country and the glory of her arms.

Capt. Charles Gratiot;[4] Chief Engineer of the Northwestern Army, under command of Major General Harrison in the campaigns of 1813–14, including defense of Fort Meigs, attack on Fort Mackinac and in command of detachment in auxiliary operations; brevet colonel of Michigan Militia, October 5, 1813.

---

[4] Graduate of the U. S. Military Academy.

Capt. Alden Partridge;[4] at West Point as assistant professor, principal assistant professor, and professor of mathematics, 1812–13; professor of engineering, 1813–16.

Capt. William Partridge;[4] Chief Engineer of the army commanded by Major General Hull, in the campaign in Michigan Territory in 1812; prisoner of war upon the surrender of Detroit, August 16, 1812, and before being exchanged, died September 20, 1812. When Hull announced his determination to surrender, Captain Partridge broke his sword across his knee and threw the pieces at Hull's feet.

Capt. Prentiss Willard;[4] engineer of the defenses of Beaufort, S. C., 1812–13; died October 12, 1813.

Capt. Joseph G. Totten;[4] Chief Engineer of the Army on the Niagara frontier in the campaigns of 1812–13, including the attack on Queenstown Heights, 1812, the capture of Fort George, 1813, and the repulse of the British flotilla on Lake Ontario, June 6, 1813; Chief Engineer in the campaign of 1814 on Lake Champlain, including the attack on La Cole Mill, Lake Champlain, and the battle of Plattsburg; blew up Fort Erie when abandoned, October 5, 1814; brevetted major, June 6, 1813, for meritorious services and lieutenant colonel, September 11, 1814, for gallant conduct at the battle of Plattsburg. For his conduct at Fort George, Totten with only four others was commended to the War Department by the general commanding for "their judicious and skilful execution in destroying the enemy's batteries"; and in the report of the repulse of the British flotilla he is reported again as "a most valuable officer," receiving the brevet of major. Having, as chief engineer, constructed the defenses of Plattsburg, Totten participated in the defeat of the greatly superior British forces and was 1 of 11 (3 being engineers) to be reported officially by General Macomb as officers "who have all distinguished themselves by their uncommon zeal and activity, and have been greatly instrumental in producing the happy and glorious result of the siege."

Capt. Samuel Babcock;[4] assistant engineer upon the construction of fortifications in New York Harbor, 1812–14, and of Military District No. 5 (Maryland and Virginia), 1813; Chief Engineer of the forces under command of Major General Smith in the defense of Baltimore, 1814.

Capt. Sylvanus Thayer;[4] Chief Engineer of the northern Army under command of Major General Dearborn in the campaign of 1812 and of the right wing of the same Army under command of Major General Hampton, to whom he was also aide de camp, in the campaign of 1813, including the combat of Chateaugay River; chief engineer of the forces under command of Brevet Brigadier General Porter in the defense of Norfolk, Va., in 1814; brevetted major, February 20, 1815, for distinguished and meritorious services.

Capt. William Cutbush;[4] assistant engineer upon the construction of fortifications in New York Harbor, 1812–15.

First Lt. [René] Edward De Russy;[4] assistant engineer upon the construction of the defenses of New York and of Sackett's Harbor, 1812–13; in the campaigns on the St. Lawrence River and Lake Champlain, 1813–14, including the repulse of the British flotilla at French's

---

[4] Graduate of the U. S. Military Academy.

> The two captains taught mathematics; the one in the line of geometrical, the other in that of algebraical demonstration.

From its very organization some commissioned officers of the corps were engaged upon the fortifications of the coast, and the majority of those who acted the part of teachers, during the first 2 or 3 years of the existence of the academy, were soon replaced by teachers and professors appointed to instruct in special subjects. By February of 1808 but one officer of the corps remained at the Military Academy, serving in the capacity of acting superintendent, and also as instructor of certain branches. In the words of Colonel Williams—

> It was not probably foreseen, that although the headquarters of the corps might be at West Point, yet the duties of the individual officers necessarily spread them along our coast from one extremity of the United States to the other, and, as the whole number of officers can be no more than sixteen, they could not in their dispersed state constitute a Military Academy. The incongruity of a stationary and errant existence of the same corps has been amply exemplified by experience.

It is not proposed to write here a history of the Military Academy or to quote the laws concerning it, although its early history was closely related to that of the Corps of Engineers. It is sufficient to say that the charge and superintendency of the academy remained with the Corps of Engineers until July 13, 1866, when by act of Congress it passed to the Army at large. As to this stewardship Ingersoll, in his History of the War Department, says—

> It is proper here to observe that, from this time until the year after the close of the War of the Rebellion, the Military Academy remained under the charge of the Corps of Engineers. During this period the academy grew from a school of humble pretensions to an institution of the most complete character, furnishing to its cadets as thorough a military education, practically and scientifically, as could be gained at almost any other similar institution in the world. The present efficiency of the academy, everywhere acknowledged, was given to it during the sixty years' control by the Corps of Engineers.

To this commendation of the work of the corps at the academy during the formative period and its first sixty years of usefulness there need only be added that the records of its graduates are the best evidences of the success of the school and from its students of that period West Point not only furnished to the Army military leaders of the highest training and ability but also supplied to the commercial and transportation interests of the country technically trained men at a time when such training was to be had at almost no other school on this continent.

The first enlisted men of the present corps were authorized by the act of February 28, 1803, which provided:

> SEC. 3. That the commanding officer of the Corps of Engineers be authorized to enlist, for a term not less than three years, one artificer and eighteen men, to aid in making practical experiments, and for other purposes, etc., etc.

In the latter part of 1802 there arose the question of the right of engineer officers to command outside of their own branch of the service and upon reference of the matter to the War Department the decision was adverse to the corps. An appeal was made to the President but without result and the two field officers of the corps resigned, Lieutenant Colonel Williams in June 1803 and Major Wadsworth in February 1805.

The controversy was definitely settled by the issuance of General Orders of April 17, 1805, confirming the previous decision and fixing the status of engineer officers as not belonging to the line. By this order, they were to assume command in the line only by special order of the President and the order was given the force of law by the enactment of the Sixty-third Article of War on April 10, 1806. Upon the acceptance by him of the President's conclusions, Colonel Williams was reappointed lieutenant colonel and Chief Engineer, April 19, 1805. A more complete account of this controversy will be found later.

On the 23d of February 1808 the corps was filled by regular promotions to the full numbers authorized by the organic act of March 6, 1802. Jonathan Williams was the colonel and Chief Engineer, Jared Mansfield the lieutenant colonel, and Alexander Macomb and Joseph G. Swift the majors. With the exceptions of Lieutenant Colonel Mansfield, who had been surveyor general of the Northwest Territory since November 1, 1803, with office at Cincinnati, and of Lt. Alden Partridge, who was retained at the Military Academy, all the officers of the corps were spread along the coasts in charge of active operations upon fortifications. The Office of the Chief Engineer was in New York Harbor.

The act of April 29, 1812, increased the number of commissioned officers from 16 to 22 by an increase of 2 each in the grades of captain, first and second lieutenant, and provided the first company of engineer troops in the following provisions:

> SEC. 1. That there be added to the Corps of Engineers two captains; two first lieutenants; two second lieutenants; with the usual pay and emoluments according to their grades respectively; and one paymaster, to be taken from the subalterns of engineers, with the pay and emoluments of a regimental paymaster, and that there be attached to the said corps, either from the troops now in service or by new enlistments, as the President of the United States may direct, four sergeants, four corporals, one teacher of music, four musicians, nineteen artificers, and sixty-two men, which noncommissioned officers, musicians, artificers, and men, together with the artificers and men already belonging to the Corps of Engineers, shall be formed into a company, to be styled a company of bombardiers, sappers, and miners, and be officered from the Corps of Engineers, according as the commanding officer of that corps may, with the approbation of the President of the United States, direct.
>
> SEC. 6. That so much of the twenty-sixth section of the act entitled "An act fixing the military peace establishment," passed the 16th day of March 1802, as confines the selection of the command of the Corps of Engineers to the said corps be, and the same is hereby, repealed.

By section 4 of the same act it was provided—

> That when any cadet[1] shall receive a regular degree from the academical staff, after going through all the classes, he shall be considered as among the candidates for a commission in any corps, according to the duties he may be judged competent to perform; and in case there shall not, at the time, be a vacancy in such corps, he may be attached to it at the discretion of the President of the United States, by brevet of the lowest grade, as a supernumerary officer, with the usual pay and emoluments of such grade until a vacancy shall happen: *Provided*, That there shall not be more than one supernumemary officer to any one company at the same time.

Under the authority of this statute supernumerary officers have been attached at different times to the corps in varying numbers as

as to call forth the most eulogistic commendations from the commanding general. Other officers were deterred from doing likewise only by circumstances which did not permit of their so doing.

---

[1] Of the U. S. Military Academy.

On the 3d of April 1818 the headquarters of the Engineer Department were transferred from New York to Washington under the following order:

> DEPARTMENT OF WAR,
> *April 3, 1818.*
>
> SIR: The President having directed that the headquarters of the Engineer Department be fixed at the seat of government, you will make your arrangements accordingly. As soon as practicable, you will order the distribution of the officers of the Engineer Corps, in such manner as the service of surveying sites, and the superintendence of the construction of works of defence may require.
>
> Until you can be otherwise accommodated, you will procure suitable rooms for offices.
>
> J. C. CALHOUN.
>
> Gen. J. G. SWIFT.

On the 7th of April 1818 regulations for the government of the Engineer Department were issued by the Secretary of War, Mr. Calhoun, with the approval of the President. About this time the Engineer Department included the Corps of Engineers, the Topographical Engineers, and the Military Academy. The Topographical Engineers were "arranged to the Engineer Department, and made subject to the orders of the Chief Engineer and commanding engineers," by formal orders dated July 2, 1818, but a number of the Topographical Engineers had for nearly 2 years been doing duty under the Chief Engineer, with the Board of Engineers, and on other stations.

On the 12th of November 1818 Bvt. Brig. Gen. J. G. Swift, Chief Engineer, resigned his commission in the Army, and on the 22d of the same month Lt. Col. W. K. Armistead, Corps of Engineers, assumed the command of the corps. On the 10th of March 1819, Lieutenant Colonel Armistead was appointed colonel, Corps of Engineers, and Chief Engineer, to rank from November 12, 1818.

By the act of March 2, 1821, to reduce and fix the peace military establishment, it was enacted:

> SEC. 1. That from and after the first day of June next, the military peace establishment of the United States shall be composed of four regiments of artillery, and seven regiments of infantry, with such officers of engineers, of ordnance, and of the staff, as are hereinafter provided for.
>
> * * * * * * *
>
> SEC. 3. That the Corps of Engineers (bombardiers excepted) and the Topographical Engineers and their assistants shall be retained in service as at present organized.

Under the operations of this act, Colonel Armistead resigned his office of Chief Engineer, and accepted the appointment of colonel of the Third Regiment of Artillery, while Brig. and Bvt. Maj. Gen. Alexander Macomb returned to service with the Corps of Engineers, as colonel and Chief Engineer. The enlisted men of the Company of Bombardiers, Sappers, and Miners were either discharged or transferred to the company of artillery which was stationed at West Point in its stead.

In releasing command of the corps in 1828 after his promotion to be major general and upon his assignment to the command of the

Army, General Macomb published the following orders, dated May 28:

> Major General Macomb, in leaving the office of Chief Engineer, which he has filled for the last 7 years, to take command of the Army, feels it but an act of justice to the officers attached to the Engineer Department to express the great satisfaction he has experienced from their zealous and efficient cooperation in every branch of the service connected with his duties.
>
> To the officers of the Corps of Engineers he makes his fullest acknowledgments for the judicious and faithful manner in which they have directed the construction of the fortifications, and other works confided to their superintendence, and for the unceasing efforts to sustain, in whatever situation they have been placed, the honor and reputation of the corps.
>
> To the officers of the Topographical Engineers, and those detailed from the line of the Army to assist in the surveys and reconnaissances relating to internal improvements, and to the gentlemen who have acted as civil engineers, Major General Macomb in like manner tenders his acknowledgments.
>
> To the commissioners and superintendents of laying out and constructing roads, the Chief Engineer has every reason for making a public acknowledgment of their faithful and valuable services.
>
> To the superintendent and officers composing the staff of the Military Academy, he takes great pleasure in expressing his sense of their enlightened and successful exertions to elevate and maintain the character of that valuable institution.
>
> And to the members of the board of engineers for fortifications and internal improvements, too much praise cannot be given for the industry and intelligence with which they have discharged the important and arduous duties committed to them.
>
> In closing this order, the Chief Engineer cannot refrain from stating with proud satisfaction the fact that during the period for which he has presided over the department, no loss has been occasioned to the public by any defalcation or neglect on the part of its officers, especially when it is considered that the amount of 6 millions of dollars has been disbursed in small sums and for items of a nature that require the greatest care and attention to satisfy the strictness of the accounting officers, and to comply with the established regulations of the department.
>
> The major general will never cease to take a great interest in the success and prosperity of the Engineer Department, and will, so far as it may be in his power, lend his aid to promote its usefulness, and, if possible, to increase its consideration in the public estimation.
>
> ALEXANDER MACOMB,
> *Maj. Gen., Chief Engr. of the U. S.*

General Macomb was succeeded as colonel and Chief Engineer by Lieut. Col. Charles Gratiot, of the Corps of Engineers.

On the 22d of June 1831, by a regulation of the War Department, the Topographical Bureau of the Engineer Department was constituted a distinct Bureau of the War Department, and the officer in charge thereof was directed to communicate directly with the Secretary of War, from whom he was to receive all his orders, and to whom he was to make all his reports.

On the 10th day of August 1831, Bvt. Brig. Gen. Simon Bernard resigned his office, and returned to France, Col. James Gadsden being appointed "Assistant Engineer" by the President in his place. This office was discontinued October 1, 1832, by virtue of the joint resolution of Congress of July 14, 1832.

By the act of July 5, 1838, to increase the military establishment of the United States, the commissioned strength of the corps was increased to 43 and mounted pay was authorized in these sections:

> SEC. 2. That the President of the United States be, and he is hereby, authorized to add to the Corps of Engineers, whenever he may deem it expedient to increase the same, one lieutenant colonel, two majors, six captains, six first and

six second lieutenants, and that the pay and emoluments of the said corps shall be the same as those allowed to the officers of the regiment of dragoons.

SEC. 3. That so much of the act passed the 29th day of April 1812, entitled "An act making further provision for the Corps of Engineers," as provides that one paymaster shall be taken from the subalterns of the Corps of Engineers, be, and the same is hereby, repealed, and that the paymaster so authorized and provided be attached to the Pay Department, and be in every respect placed on the footing of other paymasters of the Army.

SEC. 27. That it shall be the duty of the engineer superintending the construction of a fortification, or engaged about the execution of any other public work, to disburse the moneys applicable to the same, and as a compensation therefor may be allowed by the Secretary of War at the rate of two dollars per diem during the continuance of such disbursements: *Provided*, That the whole amount of emolument shall not exceed 1 percent on the sum disbursed.

But by the act of July 7, 1838, it was provided:

That no compensation shall be allowed to officers of the Engineer Department for disbursement of public money while superintending public works.

On the 6th day of December 1838, Col. and.Bvt. Brig. Gen. Charles Gratiot was dismissed from the service by an order of the President. This dismissal of General Gratiot arose from his refusal to settle his accounts in accordance with the decisions of the Comptroller of the Treasury, which General Gratiot believed were not in accordance with law. He was succeeded in the office of Chief Engineer by Lt. Col. Joseph G. Totten, who held the office until his death on April 22, 1864.

In accordance with the instructions of the Secretary of War on August 1, 1838, there were transferred, by the 18th of June 1839 to the Corps of Topographical Engineers, organized the preceding year, some 70 or more works of improvement of harbors and rivers along the Gulf, Atlantic, and Lake coasts.

The chief of the corps had for years urged upon Congress, in vain, the necessity for having at least one company of engineer soldiers as a part of our peace establishment, but the active opposition to a permanent military establishment and the strong prejudice against maintaining in time of peace even a small regular army, rendered his efforts of no avail and from the disbanding in 1821 of the Company of Bombardiers, Sappers and Miners organized for the war of 1812 there had been no engineer troops in our service.

THE ENGINEERS IN THE WAR WITH MEXICO

In 1846, after the battle of Palo Alto and the beginning of the war with Mexico, a company of sappers, miners, and pontoniers was added to the corps by the act of May 15, which provided—

That there be added to the Corps of Engineers one company of sappers, miners, and pontoniers, to be called engineer soldiers; which company shall be composed of ten sergeants, or master workmen, ten corporals, or overseers, two musicians, thirty-nine privates of the first class, or artificers, and thirty-nine privates of the second class, or laborers; in all, one hundred men.

SEC. 2. That the pay and rations of the sergeants, or master workmen, of said company shall be the same as those now allowed by law to the master workmen employed by the ordnance department, excepting that the engineer sergeants shall receive one ration only per day instead of one ration and a half; of the corporals, or overseers, the same as those now allowed by law to the armorers, carriage makers, and blacksmiths employed by the ordnance department, excepting that the engineer corporals shall receive one ration only per day, instead of one ration and a half; of the privates of the first class, or artificers, the same as those now allowed by law to the artificers employed by the ordnance depart-

> ment; of the privates of the second class, or laborers, the same as those now allowed by law to the laborers employed by the ordnance department, and of the musicians the same as those allowed by law to the musicians of the line of the Army; the said noncommissioned officers, privates, and musicians being, respectively, entitled to the same clothing and other allowances as are granted by law to noncommissioned officers, privates, and musicians of the artillery of the Army of the United States.
>
> SEC. 3. That the said engineer company shall be subject to the rules and articles of war, shall be recruited in the same manner and with the same limitation, and shall be entitled to the same provisions, allowances, and benefits in every respect, as are allowed to the troops constituting the present military peace establishment.
>
> SEC. 4. That the said engineer company shall be attached to and compose a part of the Corps of Engineers, and be officered by officers of that corps, as at present organized; they shall be instructed in and perform all the duties of sappers, miners, and pontoniers, and shall aid in giving practical instructions in these branches at the Military Academy; they shall, moreover, under the orders of the Chief Engineer, be liable to serve by detachments, in overseeing and aiding laborers upon fortifications or other works under the Engineer Department, and in supervising finished fortifications as fortkeepers, preventing injury and applying repairs.
>
> SEC. 5. That the Chief Engineer, with the approbation of the Secretary of War, be authorized to regulate and determine the number, quality, form, dimensions, etc., of the necessary vehicles, pontons, tools, implements, arms, and other supplies for the use and service of said company as a body of sappers, miners, and pontoniers.

The company so authorized was designated Company A, Corps of Engineers. Subsequently it became part of the Battalion of Engineers and, upon the reorganization in 1901, was assigned to the First Battalion of Engineers, retaining its original company letter. To it was assigned in 1846 as its first commander, Capt. Alexander J. Swift, who had shortly before returned from a tour of instruction in the French school for engineer officers at Metz. His lieutenants were Gustavus W. Smith and George B. McClellan. Lt. John G. Foster joined the company later at Tampico.

By the last of September the company had been recruited, organized, and drilled, and was ordered to join General Taylor's army, arriving at Brazos Santiago on October 11, 1846. From Brazos the company proceeded to the mouth of the Rio Grande and subsequently started upon its return to Brazos, en route to Tampico by sea, but was diverted to Matamoros and thence proceeded by marching to Tampico, where it took transport to Vera Cruz. Landing on the beach with the first line, it rendered arduous and valuable services during the siege of Vera Cruz. Captain Swift with 20 men of the company had been left sick in the hospital at Matamoros. Although still very sick, he rejoined his command at Tampico and landed with it at Vera Cruz, so weak that it was necessary to carry him ashore. Within 24 hours he succumbed entirely, and being taken on shipboard was sent by the first steamer to New Orleans, where he died a few hours after his arrival.

During the remainder of the war the company served with General Scott's command, taking part in the battles of Cerro Gordo, Contreras, Churubusco, Chapultepec, and Garita San Cosme. In many of these actions the company, in addition to performing the duties of sappers and miners, formed a part of the attacking force. At Molino del Rey, Lieutenant Foster with a detachment of 10 men from the company participated in the assault and was himself wounded. Captain Swift's early death from exposure in the field has been mentioned. The other 3 officers lived to gain the commissions of major generals during the Civil War and one of them to command the Army of the Potomac.

Nineteen officers of the Corps of Engineers served with the armies in Mexico, including the Chief Engineer, Colonel Totten, in whose professional skill General Scott had such unbounded confidence that he called him from Washington to take charge of the engineer operations of his army. None of these engineers had command of troops outside of their own branch of the service. All but the four attached to the engineer company were on staff duty and the company officers were also utilized for the same work to a considerable extent. In General Scott's army the engineers found their greatest opportunities, both from the circumstances of the campaign and from the character of the commanding general. In the war of 1812 General Scott was intimately associated in his earliest campaigns with such brilliant and earnest men as McRee, Wood, Totten, and others and valued highly the services rendered by them. In the Mexican war he followed the example set him by General Brown in 1814 and, utilizing his engineers to the fullest extent, found among them such men as Lee, Beauregard, McClellan, Isaac I. Stevens, and others whose names became household words in the great struggle to follow a few years later. That these engineers accepted their opportunities with gallantry and efficiency is evident from the record of casualties and brevets that follows below, but the full record of their services will always remain a part of the unwritten history of this war.

With General Scott were 12 engineer officers. Colonel Totten directed the siege operations in front of Vera Cruz, with the able assistance of his subordinates, and won high commendations for himself and his officers upon the conduct of the siege. He served as a member of the commission that arranged the terms of capitulation and, after the fall of the city, returned to Washington as the bearer of General Scott's despatches announcing the success of the army, receiving subsequently the brevet of brigadier general for gallant and meritorious conduct.

Captain Swift was invalided and died a few weeks later. Of the 10 engineers who served with Scott's army in the short and brilliant campaign from Vera Cruz to the City of Mexico, 1 was invalided toward the end of the movement and 7 were wounded. One of the 10 received a single brevet, 6 were twice brevetted, and 3 (Lee, Tower, and McClellan) were brevetted 3 times—all for gallant and meritorious conduct. Three of the 10 died before 1860 and 6, including, in the order of their rank in 1847, R. E. Lee, P. G. T. Beauregard, Isaac I. Stevens, Gustavus W. Smith, George B. McClellan, and John G. Foster held command as major generals or higher on one side or the other during the rebellion. Three of them commanded the opposing armies in Virginia and one (McClellan) received the thanks of Congress. The eleventh, Tower, became a brigadier general of volunteers in 1861, but was so badly wounded at Manassas in 1862 as to be incapacitated for service for 2 years, receiving five brevets, including brevets of major general in both the army and the volunteers, for gallant and meritorious conduct. The records made by this little group of officers as a whole are unequaled in our service.

Of them, General Worth, in reporting upon the operations resulting in the capture of the city of Mexico, says—

> Of the staff, Lieutenants Stevens, Smith, and McClellan, engineers, displayed the gallantry, skill, and conduct which so eminently distinguished their corps.

And General Scott upon the same operations says [5]—

> The victory of the 8th at the Molino del Rey was followed by daring reconnaissances on the part of our distinguished Engineers—Captain Lee, Lieutenants Beauregard, Stevens, and Tower. * * *
>
> * * * Captain Lee, so constantly distinguished, also bore important orders from me (September 13) until he fainted from a wound and the loss of two nights' sleep at the batteries. Lieutenants Beauregard, Stevens, and Tower, all wounded, were employed with the divisions and Lieutenants G. W. Smith and G. B. McClellan with the company of sappers and miners. Those five lieutenants of engineers, like their captain, won the admiration of all about them.

Many similar encomiums upon the gallantry and professional skill of the engineers individually and as a body will be found among the official reports of this campaign, particularly in those of General Scott, in whose esteem and confidence they held an exalted place. From among them all General Scott selected to receive his highest praise, Captain Lee, of whom in a letter to the Secretary of War dated May 8, 1857, he says in asking for a commission for Colonel Lee's son—

> I make this application mainly upon the extraordinary merits of the father—the very best soldier that I ever saw in the field. * * *

Lee held to General Scott in 1847 the same confidential relation that McRee held with General Brown in 1814, and the events of 1861–65 proved the correctness of Scott's judgment of soldiers and of Lee in particular.

The engineers who served in other fields of operation during the Mexican War were relatively less distinguished as a whole only by reason of less brilliant opportunities. Of the seven who so served two were wounded and all who were in action were brevetted for gallant and meritorious conduct. Among them were J. K. F. Mansfield, wounded and twice brevetted while Chief Engineer of General Taylor's army, who was afterwards killed at the battle of Antietam in 1862 in command of the Twelfth Army Corps; J. G. Barnard, who constructed the defenses of Tampico; W. D. Fraser, aide to General Wool, who was brevetted at Monterey, and died in 1856; H. W. Benham, who was wounded and brevetted at Monterey and became a brigadier general of volunteers in 1861; J. M. Scarritt, brevetted at Monterey, died in 1854; H. W. Halleck, brevetted for gallant conduct, major general, General in Chief, and Chief of Staff during the Civil War; and J. F. Gilmer, not in action, major general in the Confederate army.

Regarding the services during the Mexican War of the graduates of the Military Academy as a whole, the Hon. Randolph B. Marcy, Secretary of War during the administration of President Polk, expressed himself as follows in December 1848—

> Among the considerations which render the United States Military Academy at West Point an appropriate depository of the trophies of the successful

---

[5] General Scott's Report, written in the National Palace of Mexico, September 18, 1847.

victories of our arms in Mexico is the admitted fact that the graduates of that Institution contributed in an eminent degree to our unexampled career of success.

Among the graduates of the Military Academy who served during this war the engineers are entitled to a high place. Indeed, if the bare records of casualties and brevets for gallant and meritorious service in action are accepted as the best criterion, they won for themselves the highest place among graduates, having, in percentages, suffered a greater number of casualties and received a greater number of brevets than any other arm of the service.[6] And the records during the Civil War of such of these officers as lived long enough to participate in that great struggle clearly indicate that the character of their services in the Mexican War was not the result alone of fortuitous circumstances.

OFFICERS OF THE CORPS OF ENGINEERS WHO SERVED IN THE FIELD DURING THE WAR WITH MEXICO

Col. Joseph G. Totten,[4] Chief Engineer, United States Army; brevetted brigadier general for gallant and meritorious conduct during the siege of Vera Cruz, died April 22, 1864.

Maj. John L. Smith; brevetted lieutenant colonel and colonel for gallant and meritorious conduct at Cerro Gordo, Contreras, and Churubusco; died October 13, 1858.

Capt. Joseph K. F. Mansfield;[4] brevetted major, lieutenant colonel, and colonel for gallant and meritorious conduct at Fort Brown, Monterey, and Buena Vista; severely wounded at Monterey; major general, United States Volunteers, Civil War; died September 18, 1862, from wounds received at the battle of Antietam while in command of the Twelfth Army Corps.

Capt. Robert E. Lee;[4] brevetted major, lieutenant colonel, and colonel for gallant and meritorious conduct at Cerro Gordo, Contreras, Churubusco, and Chapultepec; wounded at Chapultepec; general and general in chief, Confederate States Army, during Civil War; died October 12, 1870.

Capt. Alexander J. Swift;[4] died April 24, 1847, from disease contracted during campaign.

Capt. John G. Barnard;[4] brevetted major for meritorious conduct in enemy's country; brigadier general, United States Volunteers, and brevetted four times during Civil War; died May 14, 1882.

Capt. W. D. Fraser;[4] aide to Brigadier General Wool; brevtted major for gallant and meritorious conduct in enemy's country; died July 27, 1856.

Capt. John Sanders;[4] brevetted major for gallant and meritorious conduct at Monterey; died July 29, 1858.

Capt. James L. Mason;[4] brevetted major and lieutenant colonel for gallant and meritorious conduct at Contreras, Churubusco, and Molino del Rey; severely wounded at Molino del Rey; died September 5, 1853.

---

[4] Graduate of the U. S. Military Academy.

[6] Vide The Centennial of the United States Military Academy, vol. I, p. 629. The table on p. 629 is incorrect as to the number of brevets conferred upon graduate officers of the Corps of Engineers. This number should be 29 instead of 24. All of these brevets excepting 2 were for "gallant conduct" or for "gallant and meritorious conduct" in action. Only 1 nongraduate engineer officer, Maj. John Lind Smith, served in the field and he was brevetted twice for gallant and meritorius conduct.

First Lt. Henry W. Benham;[4] brevetted captain for gallant and meritorious conduct at Buena Vista, where he was wounded; brigadier general, United States Volunteers, and brevetted four times during Civil War; died June 1, 1884.

First Lt. Peter G. T. Beauregard;[4] brevetted captain and major for gallant and meritorious conduct at Contreras, Churubusco, and Chapultepec; twice wounded at Chapultepec; general, Confederate States Army, during Civil War; died February 20, 1893.

First Lt. Jeremiah M. Scarritt;[4] brevetted captain for gallant and meritorious conduct at Monterey; died June 22, 1854.

First Lt. Isaac I. Stevens;[4] brevetted captain and major for gallant and meritorious conduct at Contreras, Churubusco, and Chapultepec; severely wounded at San Cosme Gate; major general, United States Volunteers, during Civil War; killed at battle of Chantilly, Va., September 1, 1862.

First Lt. Henry W. Halleck;[4] brevetted captain for gallant conduct in affairs of November 19 and 20, 1847; major general, United States Army, General in Chief of the Armies of the United States and Chief of Staff, United States Army, during Civil War; died January 9, 1872.

First Lt. Jeremy F. Gilmer;[4] major general, Confederate States Army, during Civil War; died December 1, 1883.

First Lt. Zealous B. Tower;[4] brevetted first lieutenant, captain, and major for gallant and meritorious conduct at Cerro Gordo, Contreras, Churubusco, and Chapultepec; wounded at Chapultepec; brigadier general, United States Volunteers, and five times brevetted during Civil War; very severely wounded at battle of Manassas, Va., August 30, 1862; died March 20, 1900.

Second Lt. Gustavas W. Smith;[4] brevetted first lieutenant and captain for gallant and meritorious conduct at Cerro Gordo and Contreras; major general, Confederate States Army, during Civil War; died June 24, 1896.

Brevet Second Lt. George B. McClellan;[4] brevetted first lieutenant and captain (twice) for gallant and meritorious conduct at Contreras, Churubusco, Molino del Rey, and Chapultepec; major general, United States Army, and commanded Army of the Potomac during Civil War; received the thanks of Congress July 16, 1861; died October 29, 1885.

Brevet Second Lt. John G. Foster;[4] brevetted first lieutenant and captain for gallant and meritorious conduct at Contreras, Churubusco, and Molino del Rey; severely wounded at Molino del Rey; major general, United States Volunteers, and four times brevetted during Civil War; commanded Eighteenth Army Corps; died September 2, 1874.

FROM 1848 TO 1861

The officers of the corps whose duties did not permit them to serve in the field during the Mexican War were engaged upon fortifications and upon other important home duties. At the close of the war the officers from the field returned to their peace duties, among the most important of which were fortifications, the Military Academy, river and harbor improvements, lighthouse construction, the Lake & Pacific

---

[4] Graduate of the U. S. Military Academy.

Railway surveys and other reconnaissances in the section west of the Mississippi River.

Company A remained in garrison in the city of Mexico after its fall and until May 28, 1848, when it marched to Vera Cruz and proceeded by transport north for station at West Point, N. Y. A detachment of 25 noncommissioned officers and men under the command of Lt. A. J. Donelson accompanied Isaac I. Stevens' survey of the Northern Pacific Railroad route in 1853. In 1858, the company under command of First Lt. J. C. Duane formed a part of the expedition sent out to Utah for the relief of Albert Sydney Johnston, leaving at West Point on March 31 a detachment of 25 enlisted men. Arriving at Fort Bridger on August 1, the return march was commenced after a halt of 8 days and the company reached West Point on October 13, having marched more than 1,100 miles in 56 days.

In September 1858 the detachment which had been left at West Point, numbering then 30 men, was sent to Fort Vancouver, Washington Territory, in anticipation of serious Indian troubles, which, however, had been settled before its arrival. Proceeding to the Cascades of the Columbia it repaired the portage road during the winter of 1858–59 and in the spring of 1859 joined Captain Wallen's expedition to open a shorter route from The Dalles to Salt Lake, returning from Salt Lake to The Dalles by the old emigrant trail in the fall of 1859. Twenty-three days out from The Dalles, 10 men of the detachment were returned with the wagon train and escort for which the route was found to be impracticable. This subdetachment, under Lt. H. M. Robert, was engaged in opening a route from the Columbia River to Puget Sound and when the difficulties regarding San Juan Island broke out, was sent to the island and employed in fortifying it. After the joint occupation was agreed upon it returned to The Dalles, where it arrived in January 1860, and rejoined the detachment which subsequently built a bridge on the Cascades portage road and a road from Fort Steilacoom to Puget Sound. In the spring of 1861 the detachment was ordered to San Francisco and in June proceeded to West Point.

Returning to the legislative history of the corps, it appears that the promotion to captains of lieutenants who had served 14 years as such was directed by the act of March 3, 1853, which provides—

> That whenever any lieutenant of the Corps of Engineers, Corps of Topographical Engineers, or Ordnance shall have served 14 years' continuous service as lieutenant he shall be promoted to the rank of captain: *Provided*, That the whole number of officers in either of said corps shall not be increased beyond the number now fixed by law.

THE CONSOLIDATION OF 1863

There were added to the corps six lieutenants and three companies by the act of August 3, 1861, which provided—

> SEC. 3. That there shall be added to each of the Corps of Engineers and Topographical Engineers, three first and three second lieutenants, to be promoted thereto in accordance with the existing laws and regulations.
>
> SEC. 4. That there shall be added to the Corps of Engineers three companies of engineer soldiers, to be commanded by appropriate officers of said corps, to have the same pay and rations, clothing, and other allowances, and to be entitled to the same benefits in every respect as the company created by the act for the organization of a company of sappers and miners and pontoniers, approved May 15, 1846.

* * * * * * *

And each of the four companies of engineer soldiers shall hereafter be composed of ten sergeants, ten corporals, two musicians, sixty-four privates of the first class, or artificers, and sixty-four privates of the second class—in all, one hundred and fifty men.

The commissioned strength of the corps was increased to 55 by the addition of 6 field officers under the following provision of the act of August 6, 1861—

That there shall be added to each of the Corps of Engineers and Topographical Engineers, by regular promotion of their present officers, two lieutenant colonels and four majors.

The Corps of Topographical Engineers had since 1831 been a distinct bureau of the War Department. Prior to that year its officers and duties had at times been under the direction of the Chief Engineer. In the midst of the Civil War it was abolished as a distinct branch of the Army and was merged into the Corps of Engineers by the act of March 3, 1863, which provided—

That the Corps of Topographical Engineers, as a distinct branch of the Army, is hereby abolished, and from and after the passage of this act is merged into the Corps of Engineers, which shall have the following organization, viz: One Chief Engineer, with the rank, pay, and emoluments of a brigadier general; four colonels, ten lieutenant colonels, twenty majors, thirty captains, thirty first lieutenants, and ten second lieutenants.

SEC. 2. That the general officer provided by the first section of this act shall be selected from the Corps of Engineers, as therein established, and that officers of all lower grades shall take rank according to their respective dates of commission in the existing Corps of Engineers or Corps of Topographical Engineers.

SEC. 3. That no officer of the Corps of Engineers below the rank of field officer shall hereafter, be promoted to a higher grade before having passed a satisfactory examination before a board of three engineers senior to him in rank; and should the officer fail at such examination, he shall be suspended from promotion for one year, when he shall be reexamined, and, upon a second failure, shall be dropped by the President from the Army.

Under the operations of this act, Col. Joseph G. Totten was appointed Chief Engineer with the rank of brigadier general and upon his death on April 22, 1864, he was succeeded by Col. Richard Delafield.

THE CORPS OF TOPOGRAPHICAL ENGINEERS

Upon the merger of the Corps of Topographical Engineers with the Corps of Engineers under the act of March 3, 1863, the latter absorbed the officers, duties, records, and all else pertaining to the former, including its history.

Like the Engineers, the Topographical Engineers first appeared in our service during the Revolutionary War, in the authorization, under the title of "geographer," of officers who performed duties such as devolved in later years upon the Topographical Engineers as a part of their functions.

Such officers were first authorized by the resolutions of July 25, 1777, as follows:

Resolved, That General Washington be empowered to appoint Mr. Robert Erskine, or any other person that he may think proper, geographer and surveyor of the roads, to take sketches of the country, the seat of war, and to have the procuring, governing, and paying the guides employed under him, the general to fix the pay of the said geographer, etc., and the allowance that shall be made to the guides.

The first geographer was replaced by the following resolution of December 4, 1780—

> *Resolved*, That Mr. Simeon De Witt be appointed geographer in the Army, in the room of Robert Erskine, deceased.

On July 11, 1781, the following resolution was passed:

> *Resolved*, That the geographer to the main Army, and also the geographer to the southern army, be styled "Geographer to the United States of America," and commissioned and considered as such, and that they perform such service as the Commander in Chief, and commanding officer of the southern army may judge necessary to assign them, respectively:

On November 12, 1782, the following action was taken in Congress:

> Whereas, no provision has been made by Congress for the geographers to the Armies of the United States: Therefore,
>
> *Resolved*, That the geographer to the main Army, and the geographer to the southern department, be each of them allowed $60 per month, three rations per day, forage for two saddle horses, one two-horse covered wagon, six and two-thirds dollars per month for a servant, for whom they shall be entitled to draw one ration per day, and the clothing allowed to a private soldier; that the assistant geographers, if such officers shall be judged necessary by the Commander in Chief, be allowed $30 per month, one ration per day, and forage for one saddle horse; that when chain bearers shall be employed, not being soldiers, they shall each be allowed-half a dollar per day.

The compensations given above were those which pertained in the Army to the grades of colonel and captain, respectively.

Upon the close of the war and the disbanding of the Army, the geographer of the United States was continued in office as surveyor of the public lands, as appears from the following resolutions:

> MAY 27, 1785.
>
> *Resolved*, That the geographer of the United States be continued in office for a term not exceeding three years, and that he be allowed during his continuance in office $6 per day for his services and expense.
>
> JUNE 9, 1785.
>
> *Resolved*, That the Board of Treasury advance to Thomas Hutchins, geographer of the United States, $700 on account.
>
> That the Board of Treasury advance Thomas Hutchins, geographer of the United States, $6,000, for which he is to be accountable, to be applied by him, from time to time, to the use of the several officers concerned in carrying into execution, the ordinance for ascertaining the mode of disposing of lands in the western territories.

After the establishment in 1794 of a Corps of Artillerists and Engineers, and the formation by them of a school at West Point, the necessity of topographical engineers in our service was recognized in the War Department, as will appear from the following extract from some notes furnished the Committee on the Military Establishment in Congress by Col. Timothy Pickering, late Secretary of War, dated February 3, 1796:

* * * * * * *

> The Corps of Artillerists and Engineers appears to be an important establishment. To become skillful in either branch of their profession will require long attention, study, and practice, and because they can now acquire the knowledge of these arts advantageously only from the foreign officers, who have been appointed with a special reference to this object, it will be important to keep the corps together for the present, as far as the necessary actual service will permit. Its principal station may then become a school for the purpose mentioned. To render this school more complete, provision is wanting for a geographical engineer and draughtsman. Such a one may now be retained for the establishment of a captain.

No officers with the special functions of topographical engineers were, however, provided for our Armies until the early part of the war of 1812 with Great Britain, when Congress by an act for the better organization of the General Staff of the Army, passed March 3, 1813, made provision for eight topographical engineers and as many assistants, the former to have the brevet rank of majors and the latter the brevet rank of captains. The topographical engineers were to be taken from the line, or not, as the President might deem expedient, and the assistants were to come from the line. Officers taken from the line and transferred to the staff received only the pay and emoluments attached to their rank in the staff, but their transfer was without prejudice to their rank and promotion in the line according to their said rank and seniority.

Under the authority of this law the Corps of Topographical Engineers was organized by the appointment by the President of the following officers:

Topographical engineers

	Appointed	Rank in line
Maj. John Anderson	Apr. 12, 1813	Captain, Nineteenth Infantry.
Maj. Paul H. Perrault	Apr. 12, 1813	
Maj. Isaac Roberdeau	Apr. 29, 1813	
Maj. Simon Z. Watson	Aug. 3, 1813	
Capt. Thomas Clark	Apr. 1, 1813	Second lieutenant, Second Artillery.
Capt. James Kearney	Apr. 12, 1813	Third lieutenant, Fifth Infantry.
Capt. Daniel Rose	July 20, 1813	Third lieutenant, Twenty-first Infantry.
Capt. Benjamin Connor	Aug. 3, 1813	Third lieutenant, First Artillery.

Of these officers, Majors Anderson and Roberdeau, and Captains Clark, Kearney, and Rose were assigned to the northern division of the Army, and Majors Perrault and Watson, with Captain Connor, to the southern, under the following instructions published in May 1813:

Duties of Topographical Engineers and Their Assistants

To make such surveys, and exhibit such delineations of these as the commanding general shall direct; to make plans of all military positions (which the Army may occupy) and of their respective vicinities, indicating the various roads, rivers, creeks, ravines, hills, woods, and villages to be found therein; to accompany all reconnoitering parties sent out to obtain intelligence of the movements of the enemy or of his position, etc.; to make sketches of their route, accompanied by written notes of everything worthy of observation thereon; to keep a journal of every day's movements, when the Army is on march, noticing the varieties of ground, of buildings, of culture, and the distances and state of the road between given points throughout the march of the day and, lastly, to exhibit the positions of contending armies on fields of battle, and the disposition made, whether for attack or defense.

Major Watson died the 1st of February 1814, and the appointment of Benjamin Connor as captain was negatived by the Senate in March of 1814. On the 1st of January 1815 the Topographical Department consisted of the following officers, to wit:

Maj. John Anderson; Maj. Paul H. Perrault, Maj. Isaac Roberdeau; Maj. J. C. Warren, appointed 30th of March 1814; Maj. John J. Abert, appointed 22d of November 1814; Capt. Thomas Clark; Capt. James Kearney; Capt. Daniel Rose; Capt. Gamaliel Pease, appointed 15 of July 1814, from second lieutenant, First Infantry. The new appointments were attached to the southern division of the Army.

In the year 1815, and until the termination of the war, the same officers remained in service. On the conclusion of peace under the Treaty of Ghent, and the consequent hasty reduction of the Army at the close of the session of Congress, the Topographical Engineers being considered as exclusively appertaining to the general staff, were unprovided for by the act of the 3d of March 1815, fixing the peace military establishment, and were mustered out of service June 15, 1815. This act, however, authorized the President provisionally to retain certain officers whose services might be of importance, and who might not be included in the details of the law.

As the reports of the Topographical Engineers stationed on the frontiers were made to commanding generals of divisions or detachments, under circumstances unfavorable to a perfect and minute delineation of the objects of their attention, the end of the war found them in an unfinished state, although the notes and sketches of many parts of the country had been obtained with much labor and preserved with care. The President being advised of this condition, as well as of the importance from every other consideration of retaining this branch of the Army in the peace establishment, when the duties that would necessarily be assigned to it could be pursued with better success, he, on the 19th of June 1815, retained in service two majors, Anderson and Roberdeau, who were directed, under special orders from the War Department, to complete the surveys on the northern frontier and Lake Champlain, together with some other matters which the unexpected close of the war had suspended, and to report to the Chief Engineer, General Swift, for the execution of this duty.

These duties were performed, but, by extending these surveys and geological researches, the importance of the continuance of the corps was proportionally increased, and the succeeding Congress found them still more deeply engaged in their useful investigations than the circumstances of the late war permitted.

As the authority of Congress was necessary to the reestablishment of the corps, and presuming that sufficient information had not been imparted to lead to a true knowledge of its usefulness in time of peace as well as in war, the following memoir was prepared with a view to directing the attention of Congress to the subject as one of much importance in the development of the civil as well as the military resources of the nation:

MEMOIR

Engaged in the execution of duties, the importance of which on a large scale appears not yet to be sufficiently appreciated, it would be deviating from the practice of all topographers not to present such views of the performance of their functions in the public service as are important to the Nation, and which the particular circumstances of the country and the infancy of this branch of public economy so forcibly impress as a military and civil or political duty.

The undersigned have in the course of the war had to perform necessary services in the Topographical Departments at different points; at the close of the contest, they had, conjointly, to make topographical surveys where the want of accurate information had been felt in the progress of it, and which would be again experienced should war at any future period be renewed.

Under an order of June last, with which the undersigned were honored by the President of the United States, a considerable portion of the northwestern and western Territories has been critically explored by them. As much of this reconnoiter as the limited time since their return would admit of, has been hastily sketched, which, together with the different detailed reports on the subject, have been transmitted to General Swift. The intention, therefore, of this memoir is merely the reflections which their sense of duty imposes upon them to offer, with the utmost deference, to the chief of the department, for the consideration of the President of the United States.

The duties of the topographical department of an army embrace a variety of subjects; the views of ground and the facilities for movements of every kind; the profiles of positions and the routes which are, or may be opened are usually considered by those who have not entered into the spirit of the science as comprehending the whole of its duties. But a great portion of topographical research would be lost to the public were its functions so limited or were they confined to the mere selection for sites of camps or fields of action. It becomes, therefore, the duty of those who have been honored with public confidence in this department, if they have not the opportunity of carrying into operation the functions of their immediate stations on that scale or to that extent which the present deficiency of this kind of information so imperiously calls for, that they should at least point out what they conceive to be necessary for the strength of the country, for knowledge is in no case so really identified with strength as in the knowledge of the country, which is our own, where it is weak and open to assault, where it is defensible, and, in short, where its resources in a military view are feeble, and where and how susceptible of defense.

It is in this point of view that it becomes associated with the engineers of fortification. It is here that their functions sustain and perfect each other; and it is in this view that it will be best seen how necessary the subdivision of the science, like the subdivision of labor, contribute to the perfection of each other and of the whole.

The engineers of works operate on fixed positions; their duties may be considered sedentary, while the topographer has to trace the routes, not only of the army to which they belong but to preoccupy, reconnoiter, and know every route by which an enemy may approach. Under this view of their respective duties, among others equally impressive, the expediency of placing both departments under one chief is, with great deference, submitted.

But yet these are not all the duties which properly belong to the Topographical Department. Much of its utility would be thrown away if their functions commenced and ceased with immediate military action. It is through this department that the experience of a campaign past is rendered subservient to future ones, or that the same duties are not to be performed in detail on the same subjects with every new army. The recording topographical details for future use is one of the great economical functions of this department.

Nor does it cease here; the same intelligence which surveys the roads and ravines, the hills, woods, valleys, and declivities, the morasses, and mounds, which so much influence military operations and often decide the fortunes of war, requires the association of other inquiries, which bear analogy to statistical science, and which renders that branch of knowledge a necessary part of military record. A numerous population, in a country which is to become the theater of operations, present many considerations which may produce very different results from those presented by a simple description, or the most minute details of the ground. The knowledge of the condition, as well as numbers of the population, comes within the same scope; a fertile or a sterile country, even the temper, dispositions, and habits of the people, their mode of life, their food, stock, and civil condition in relation to their own government, become a part of the objects upon which the topographer has to report, because without these a knowledge of the ground alone would be insufficient.

Under such views it may be perceived that it is of the utmost moment to render the circle of the duties of this branch as complete as possible; that its records should present a sort of civil history, as well as a picturesque detail, and the more perfect these several branches are combined and developed the greater will be the advantage to the country.

The immediate objects of the present memoir are the surveys and reconnoiter executed by the undersigned within the past year, a part of which, with reports on some of the subjects, have been presented to Brigadier General Swift. They embrace topographical surveys and views of detached points only, but these of great importance with a view to future precaution. The first contains surveys on the Champlain frontier; the second, surveys on the Cadaraqui; a third of Oswego, on Lake Ontario; and the fourth on the scenes of those brilliant operations which have rendered both shores of the Niagara Strait memorable in our annals. Of these several objects drawings have been prepared, though not in that complete and finished state which their importance demands. But the field-notes and sketches are so ample and minute as to require only the necessary time and labor to place them in a state that will not be inferior in usefulness to those of any other nation. The drawings and field notes of Mackinaw and Detroit are equally minute and require time only to arrange them perfectly.

In some of these surveys it has presented to our reflection that the positions which have been established in former wars between France and England were selected with very great skill, so much so that were the country to be settled anew, by a scientific people, the same sites would be preferred to any others which are contiguous to them. Among these may be preeminently noticed Crown Point, Kingston in Canada, Oswego, and Niagara, in the State of New York, all which were originally selected by the French and improved or occupied subsequently by the British.

Upon commencing a topographical tour on the waters of Lake George, on the route to Champlain, the principal point which presented itself to our consideration was Crown Point. The idea of General Lloyd, though crude in its details, was very sound in its design; that of operations by Lake Champlain and Albany so as to separate the Eastern from the Middle States by the Hudson. It was attempted by Burgoyne, and menaced, with equal futility, by Prevost in the late war. Independently of those political causes which have existed, and may yet exist, to encourage the renewing of such a design (for nations, like individuals, are often disposed to retrieve disasters upon the very ground on which they suffered), Crown Point appears to have been not duly regarded in the late war, for it presents the best position for a depot, with all the advantages of military defense.

These views, which might be enlarged to a voluminous extent, are respectfully submitted as evidences of what may be accomplished in a short period by attentions well directed and reported. But the field notes and sketches are valuable, both from their accuracy and minuteness and because, above all, they are the fruit of great toil, which toil must be renewed on the same subjects should any future war arise, if the knowledge now possessed be not profitably used.

The undersigned do not hesitate to recommend, without the apprehension of being mistaken, or of its being attributed to any other than public motives, the completion of a frontier military survey of the whole interior and exterior of the United States. This work, together with the duties necessarily arising out of the survey of the seacoast, and the establishment of the boundary line between the United States and the British Provinces in Canada, can be executed with the best effect by a Corps of Topographical Engineers, under the immediate direction of the Chief of the Engineer Corps, and by them, with the employment of the military, at much less expense than that which these duties could be obtained from persons employed out of civil life in those services.

All which is respectfully submitted.

JOHN ANDERSON,
Topographical Engineer.
I. ROBERDEAU,
Major, Topographical Engineers.

The Hon. WILLIAM CRAWFORD,
Secretary of War.
WASHINGTON, *January 16, 1816.*

By the act of April 24, 1816, organizing the general staff and making further provision for the Army of the United States, three topographical engineers and two assistants were provided for each military division. The corps formed under this arrangement consisted of the following officers:

Maj. John Anderson, to rank from April 12, 1813; Maj. Isaac Roberdeau, to rank from April 29, 1813; Maj. John J. Abert, to rank from November 22, 1814; Maj. James Kearney, appointed April 29, 1816; Maj. Stephen H. Long, appointed April 29, 1816; Maj. John Wilson, appointed April 29, 1816.

There were no assistant topographical engineers appointed at this time. Of the above officers, Majors Anderson, Roberdeau, and Abert were attached to the northern, and Majors Kearney, Long, and Wilson to the southern division of the Army.

The Board of Engineers for fortifications having been organized in November of 1816, several officers of the Topographical Engineers were at once attached to the board for the purpose of making the necessary surveys. By the close of 1817 there had been detailed for duty with this board Maj. Isaac Roberdeau, Maj. John J. Abert, Maj. James Kearney, and Capt. William T. Poussin, aide de camp to General Bernard.

On the 2d of July 1818 the following General Order, from the Adjutant and Inspector General's Office, was issued:

> The Topographical and assistant Topographical Engineers are arranged to the Engineer's Department, and are made subject to the orders of the chief and commanding engineers.
>
> When orders or instructions are given to such as are now attached to the command of any general, the communication will be made through him.
>
> By order.
>
> DANIEL PARKER,
> *Adjutant and Inspector General.*
>
> NOTE.—I send this to the Adjutant Generals of Divisions.—D. P.

The Topographical Engineers were thus constituted a part of the Engineer Department, and at this time were engaged in explorations in the West, and in surveys along the seaboards for fortifications.

In August 1818, a Topographical Bureau was established by the War Department, and Major Roberdeau was stationed in Washington to take charge of its arrangement under the immediate direction of the Secretary of War and the Chief Engineer. At this period is to be dated the origin of an institution which was so important to the future demands of the Government.

By the act of March 2, 1821, to reduce and fix the peace military establishment of the United States, it was provided—

> That the Topographical Engineers and their assistants shall be retained in service as at present organized.

That organization allowed six officers with the rank of brevet major, and four with the rank of brevet captain, these numbers being fixed without regard to the number of divisions or brigades in the Army.

By the act of April 30, 1824, organizing a Board of Engineers for Internal Improvements, the additional duties devolved upon the officers of Topographical Engineers, in the surveys and reconnaissances needed by this board, were of such magnitude that a large number of officers from the line of the Army, as well as civil engineers, had to be employed. During the season of 1824, 25 officers of the line of the Army and 30 civilians were employed under the directions of Topographical Engineers upon the various surveys in progress, and from this time to the organization of the Corps of Topographical Engineers, in 1838, about this number of officers and civil-engineer assistants were annually employed on topographical duty.

After the death of Lt. Col. Isaac Roberdeau, on the 15th of January 1829, Lt. Col. J. J. Abert was ordered to Washington by General

Gratiot to take the charge of the Topographical Bureau of the Engineer Department, and on the 20th of February 1829 was appointed assistant to the Chief Engineer—

In relation to such reconnaissances and surveys, both for military and civil purposes, as may be entrusted to topographical engineers, assistant topographical engineers, or civil engineers, under the direction of the Engineer Department.

On the 10th of June 1830 the following order, by direction of the Secretary of War, was issued by the Chief Engineer:

The Board of Engineers for Internal Improvements is hereby organized, to consist of the following officers, viz:

General Bernard, assistant engineer; the topographical engineer in charge of the Topographical Bureau of the Engineer Department; such officers of the Corps of Engineers as may be at any time attached to the board by the Chief Engineer.

The engineer or other officer, civil or military, who may have conducted the surveys relative to any project submitted to the board, will be considered a member of the board during the preparation of the report on such projected work, and for that purpose only.

The board will, as heretofore, report to and receive their orders from the Engineer Department.

Major Poussin will continue to act as assistant to the board.

In consequence of the additional duties hereby assigned to the officer in charge of the Topographical Bureau, that part of Engineer Order No. 3, dated the 20th of February 1829, which requires him to perform the duties of assistant to the Chief Engineer in certain cases, is rescinded.

By order of the Secretary of War.

C. GRATIOT,
Brigadier General.

On the 21st of June, 1831, the Topographical Bureau was removed from the charge of the Engineer Department and was constituted a distinct bureau by the following regulation issued by the War Department:

1. The Topographical Bureau will hereafter constitute a distinct bureau of the War Department, and the officer in charge thereof will communicate directly with the Secretary of War, from whom he will receive all his orders and to whom he will make all his reports.

2. All reports, returns, and communications from officers of the Topographical Engineers, or others on topographical duty, will hereafter be made to the officer in charge of the Topographical Bureau, through whom, in addition to his previous duties, all orders to officers of the Topographical Engineers, or others on topographical duty, will hereafter pass.

3. The officer in charge of the Topographical Bureau will comply with any application from the Chief Engineer for any original document in said bureau, or for copies of the same, and for surveys for purposes of fortifications.

P. G. RANDOLPH,
Acting Secretary of War.

By the act of July 5, 1838, to increase the military establishment of the United States and for other purposes, it was enacted:

SEC. 4. That the Corps of Topographical Engineers shall be organized and increased by regular promotions in the same, so that the said corps shall consist of one colonel, one lieutenant colonel, four majors, ten captains, ten first lieutenants and ten second lieutenants.

SEC. 5. That vacancies created by said organization over and above those which can be filled by the present corps, shall be taken from the Army, and from such as it may be deemed advisable of the civil engineers employed under the act of the 30th of April 1824; that the pay and emoluments of the officers of said corps shall be the same as are allowed to officers of similar rank in the regiment of dragoons.

SEC. 6. That the authority to employ civil engineers in the act of the 13th of April, 1824, be and the same is hereby repealed after the passage of this act.

Year	Month	Element	Dates	Station
1909	Feb. 1 to Mar. 31	Battalion less Companies E and H.		Camp Columbia, Habana, Cuba.
		Companies E and H		Washington Barracks, D. C.

NOTE.—At 12 M., Mar. 31, 1909, participated in the ceremony of lowering the flag of the United States and hoisting the flag of the Republic of Cuba at Camp Columbia, Cuba, and then proceeded to Habana and embarked on the transports *Sumner* and *McClellan* for the United States.

Year	Month	Element	Dates	Station
	April	Battalion less Companies E and H.	1-4	En route to Newport News, Va. (transports *Sumner* and *McClellan*).
			5-6	En route to Washington, D. C. (steamer *Norfolk*).
		Headquarters and Company G	7-27	Washington Barracks, D. C.
			28-30	En route to San Francisco, Calif.
		Companies E and H	1-30	Washington, Barracks D. C.
		Company F	7-24	Do.
			25-30	En route to Vancouver Barracks, Wash.
	May	Headquarters and Company G	1-4	En route to San Francisco, Calif.
			5-13	En route to Honolulu (U. S. Army Transport *Sheridan*).
			14-31	Fort De Russy, T. H.
		Companies E and H	1-27	Washington Barracks, D. C.
			28-31	En route to San Francisco, Calif.
		Company F	1-31	Vancouver Barracks, Wash.
	June	Headquarters and Company G	1-30	Fort De Russy, Honolulu, T. H.
		Companies E and H	1-3	En route to San Francisco, Calif.
			4	Aboard transport *Logan*.
			5-30	En route to Manila, P. I.
		Company F	1-30	Vancouver Barracks, Wash.
	July	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Companies E and H	1	En route to Manila, P. I.
			2	En route from Manila, P. I., to Fort Mills, P. I.
			3-31	Fort Mills, Corregidor, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
	Aug. 1 to Nov. 30	Headquarters and Company G		Fort De Russy, Honolulu, T. H.
		Companies E and H		Fort Mills, P. I.
		Company F		Vancouver Barracks, Wash.
	December	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-30	Fort Mills, P. I.
			31	Fort Santiago, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
		Company H	1-31	Fort Mills, P. I.
1910	January	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-31	Fort Santiago, Manila, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
		Company H	1-29	Fort Mills, Corregidor, P. I.
			30-31	Camp Otis, Manila, P. I.
	February	Headquarters and Company G	1-28	Fort De Russy, Honolulu, T. H.
		Company E	1-15	Fort Santiago, Manila, P. I.
			16-25	Maneuvers—marched to Orani, Bataan, P. I.
			26-28	Orani, Bataan, P. I.
		Company F	1-28	Vancouver Barracks, Wash.
		Company H	1-16	Camp Otis, Manila, P. I.
			17-27	Maneuvers.
			28	Camp Otis, Manila, P. I.
	March	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1	Orani, Bataan, P. I.
			2	En route to Manila, P. I.
			3-8	Camp Otis, Manila, P. I.
			9-31	Fort Santiago, Manila, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.
	April	Headquarters and Company G	1-30	Fort De Russy, Honolulu, T. H.
		Company E	1-30	Fort Santiago, Manila, P. I.
		Company F	1-30	Vancouver Barracks, Wash.
		Company H	1-30	Fort Mills, Corregidor, P. I.
	May	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-31	Fort Santiago, Manila, P. I.
		Company F	1-31	Target Range, Proebstel, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.
	June	Headquarters and Company G	1-30	Fort De Russy, Honolulu, T. H.
		Company E	1-27	Fort Santiago, Manila, P. I.
			28-30	Camp Ward Cheney, Cavite, P. I.
		Company F	1-19	Vancouver Barracks, Wash.
			20-30	American Lake, Cosgrove, Wash.
		Company H	1-30	Fort Mills, Corregidor, P. I.
	July	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-31	Camp Ward Cheney, Cavite, P. I.
		Company F	1-31	Cosgrove, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.

Capt. Thomas B. Linnard;[4] brevetted major for gallant and meritorious conduct at Buena Vista; died April 24, 1851.

First Lt. William H. Emory;[4] brevetted captain and major for gallant and meritorious conduct at San Pasqual, San Gabriel, and Plains of Mesa, Cal.; brigadier general and major general, United States Volunteers, during Civil War, commanding Nineteenth Army Corps, and three times brevetted; died December 1, 1887.

First Lt. Jacob E. Blake;[4] highly distinguished at Palo Alto, where he was subsequently accidentally killed, May 9, 1846.

First Lt. Lorenzo Sitgreaves;[4] brevetted captain for gallant and meritorious conduct at Buena Vista; died May 14, 1888.

First Lt. William H. Warner;[4] brevetted captain for gallant and meritorious conduct in California; severely wounded at San Pasqual; killed by Indians in the Sierra Nevada, September 26, 1849.

First Lt. Eliakim P. Scammon;[4] brigadier general, United States Volunteers, during Civil War; died December 7, 1894.

First Lt. Charles N. Hagner; died July 14, 1849.

Second Lt. John C. Fremont; major general, United States Army, during Civil War; died July 13, 1890.

Second Lt. Joseph D. Webster; brigadier general, United States Volunteers, during Civil War and brevetted major general United States Volunteers; died March 12, 1876.

Second Lt. George Thom;[4] died June 29, 1891.

Second Lt. George G. Meade;[4] brevetted first lieutenant for gallant conduct at Monterey; brigadier general and major general, United States Volunteers and United States Army, during Civil War; commanded Fifth Army Corps and Army of the Potomac (June 28, 1863, to June 1865); received the thanks of Congress; died November 6, 1872.

Second Lt. Martin L. Smith;[4] brevetted first lieutenant for meritorious conduct in enemy's country; major general, Confederate States Army, during Civil War; died July 29, 1866.

Second Lt. John Pope;[4] brevetted first lieutenant and captain for gallant and meritorious conduct at Monterey and Buena Vista; major general, United States Volunteers, and brigadier general, United States Army, during Civil War; commanded Army of the Mississippi and Army of Virginia; major general, United States Army, 1882; died September 9, 1892.

Second Lt. William B. Franklin;[4] brevetted first lieutenant for gallant and meritorious conduct at Buena Vista; major general, United States Volunteers, during Civil War; commanded Sixth and Nineteenth Army Corps; wounded at Sabine Cross Roads; died March 8, 1903.

Bvt. Second Lt. William G. Peck;[4] resigned October 2, 1855; professor of mathematics, Columbia College; died February 7, 1892.

Bvt. Second Lt. Thomas J. Wood;[4] brevetted first lieutenant for gallant and meritorious conduct at Buena Vista; major general, United States Volunteers, during Civil War and commanded Fourth Army Corps; wounded at Stone River and Lovejoy's Station, died.

Bvt. Second Lt. Edmund L. F. Hardcastle;[4] brevetted first lieutenant and captain for gallant and meritorious conduct at Contreras,

---

[4] Graduate of the U. S. Military Academy.

Churubusco, and Molino del Rey; resigned April 30, 1856; died August 11, 1899.

Bvt. Second Lt. Francis T. Bryan;[4] brevetted first lieutenant for gallant and meritorious conduct at Buena Vista, where he was wounded; resigned June 10, 1861.

Bvt. Second Lt. George H. Derby;[4] brevetted first lieutenant for gallant and meritorious conduct at Cerro Gordo, where he was severely wounded; died May 15, 1861.

FROM 1848 TO 1861

Upon the close of the Mexican War the Topographical Engineers resumed in full their peace duties, which continued to increase in numbers and importance of works assigned to their charge.

The act of March 3, 1851, causing details of engineer officers to be made by the President, for the purpose of superintending the construction and renovation of lighthouses, as well as the act of August 31, 1852, creating a Light-House Board, applied to the Corps of Topographical Engineers, and its officers were detailed equally with the officers of the Corps of Engineers upon that duty.

By the act of August 3, 1861, 3 first and 3 second lieutenants were added to the corps, and by the act of August 6, 1861, there were added, by regular promotion, 2 lieutenant colonels and 4 majors, raising the commissioned strength to 48.

Section 2 of this act further provided:

> That there shall be added to the Corps of Topographic Engineers one company of soldiers, to be commanded by appropriate officers of said corps, to have the same pay and rations, clothing, and other allowances, and to be entitled to the same benefits in every respect, as the company created by the act for the organization of a company of sappers and miners and pontoniers, approved May 16, 1846. The said company shall be subject to the rules and articles of war, and shall have the same organization as the companies of engineer soldiers attached to the Corps of Engineers.

On the 9th of September 1861, Col. J. J. Abert was retired from active service, and was succeeded as colonel, Corps of Topographical Engineers, by Lt. Col. Stephen H. Long, of that corps.

By the act of March 3, 1863, quoted above, the Corps of Topographical Engineers was merged in the Corps of Engineers, producing an organization that would seem to have been contemplated by Majors Anderson and Roberdeau, the senior officers of this corps, in their memorial of January 16, 1816.

THE CIVIL WAR

The outbreak of the Civil War found the Army with two organizations of Engineers having an aggregate authorized strength of 79 commissioned officers and 1 company of engineer soldiers of 100 men, the latter being a part of the Corps of Engineers. The acts of August 3 and August 6, 1861, increased their commissioned strength to a total of 103, and added 3 companies to the Corps of Engineers and 1 company to the Topographical Engineers, raising the authorized enlisted strength to a total of 750. The consolidation act of

---

[4] Graduate of the U. S. Military Academy.

March 3, 1863, further increased the commissioned strength to 105. With these numbers the engineers served through the war.

In January 1861, the Engineer Company (A) was in garrison at West Point with a detachment on the Pacific Coast. On January 20, 1861, it proceeded to Washington for guard duty at public buildings and arsenals and formed a part of President Lincoln's escort upon his inauguration. It left Washington on April 3, 1861, and on the 7th embarked at New York under sealed orders, arriving at Fort Pickens April 16. The works were put in a state of defense and in September the company returned to West Point. It was again transferred to Washington October 31 and was there joined by the Pacific Coast detachment which had left San Francisco in June and, after going to West Point, had been called to the Capital for duty in the construction of defenses and in the instruction of Volunteer Engineer troops.

Of the three additional companies authorized to the Corps of Engineers by the act of August 3, 1861, Company B was organized at Portland, Maine, and Company C at Boston, Mass., and both joined Company A at Washington in the fall of 1861. Company D was organized by transfers from A, B, and C on July 4, 1862, while the Army of the Potomac lay at Harrison's Landing, Va. The company authorized to the Corps of Topographical Engineers was not organized until after the close of the war and then became Company E of the Battalion of Engineers. Much difficulty was experienced in obtaining recruits for the companies, and it was not until late in 1862 that they acquired approximately their full strength under special regulations authorizing transfers from other troops of the line.

Until 1866 these Engineer troops had no authorized battalion organization. Serving together throughout the war, they were in fact merely an aggregation of companies commanded by the senior officer present, but a provisional battalion was formed when the companies were assembled. This battalion was almost invariably referred to in orders and in correspondence as the Engineer Battalion or the Battalion of Engineers. In General Orders No. 79, Adjutant General's Office, March 31, 1863, the organization was called the Battalion of Sappers, Miners, and Pontoniers, and Maj. J. C. Duane was formally assigned to its command. By this order a complement of company officers was specified, but no battalion commissioned staff was assigned. Such staff officers were, however, detailed from among the company officers, an acting quartermaster being first appointed in March 1863 and an adjutant in August of the same year. The battalion was first recognized as such by statute only incidentally in the act of June 20, 1864, providing a battalion noncommissioned staff, as follows:

> Sec. 4. That there be added to the Battalion of Engineers one sergeant major, who shall be paid thirty-six dollars per month, and one quartermaster sergeant, who shall also be commissary sergeant, who shall be paid $22 per month.

OPERATIONS OF THE BATTALION OF ENGINEERS IN THE CIVIL WAR

As a part of the Army of the Potomac, the Battalion of Engineers, after the assembling of Companies A, B, and C, at Washington, was engaged upon construction of the defenses of the city during the winter of 1861–62, and upon training in the use of pontoon equipage with which it was to be so largely concerned later in the war. Leaving Washington on February 24, 1862, it threw a pontoon bridge of 60 boats across the Potomac River at Harpers Ferry on the 26th for the passage of General Banks' corps into Virginia. This bridge, the first of importance during the war, was constructed in 8 hours under conditions of peculiar difficuty, the Potomac being at a high freshet level and filled with ice and drift carried by a torrential current. The battalion and its officers were highly commended for their energy and skill shown in its initial field service. The reputation thus early established was later fully maintained.

Early in March the battalion returned to Washington and, after marching to Fairfax and back, proceeded on March 27 to Fort Monroe with the bridge equipage. From this time until the close of the war it served with the Army of the Potomac in all its campaigns and operations. These included Yorktown, Fair Oaks, Mechanicsville, Gaines' Mill, White Oak Swamp, Malvern Hill, Antietam, Fredericksburg, Chancellorsville, the Rappahannock, Gettysburg, the Wilderness, Spottsylvania, River Po, North Anna, Cold Harbor, siege of Petersburg, Hatcher's Run, and the final movement to Appomattox Court House. In many instances, beginning at Malvern Hill and extending through all of the above operations, it was placed in the line of battle as infantry in emergencies requiring strengthening of the long lines held by the Army. In the final campaign it was attached to headquarters of the Army and was present at the surrender of General Lee, its officers performing staff duty at General Meade's headquarters.

The battalion performed throughout the war the many duties assigned to Engineer troops in our service as pontoniers, sappers, miners, and pioneers. Its special assignment was, however, to the charge of the bridge trains that accompanied the Army of the Potomac in all its movements from 1862 to 1865 and the construction of the bridges necessary to pass that Army and its heavy trains across the many deep and wide streams found in the field of operations. These floating bridges were without parallel in number and magniture, attaining lengths of 2,000 feet or more, and included repeated crossings of the Potomac, Rappahannock, Chickahominy, and James Rivers, against freshets, drift, ice, and strong currents.

As an illustration of the work of the battalion as pontoniers there may be cited the bridge thrown across the James River below Windmill Point for the passage of the Army of the Potomac to the south side of the river in the campaign of 1864. The river at this point was 2,100 feet wide and the bridge was composed of a trestle 150 feet long on the north bank and a floating bridge of 101 pontoons. With a depth of 12 to 15 fathoms in the channel and strong tidal currents, it was necessary to moor the bridge to vessels anchored both above and below for that purpose and to provide a draw for the passage of craft passing up and down the river. Begining at 4 p. m., June 14th, the bridge was constructed from both ends and by rafts and was completed by 11 p. m. of the same day. At midnight the artillery began to cross, and by midnight of the 16th the whole Army was on the south side of the James with its artillery and trains and without accident or delay of any kind due to the bridge.

A portion of the Infantry and Cavalry were ferried over, but this bridge carried the remainder of the army and its impedimenta, including 3,000 or more head of beef cattle.

Many bridges were laid or withdrawn under fire and in forced passages. Infantry were repeatedly ferried across streams under fire as a preliminary to the construction of bridges for the use of the Army. It was in such an operation that Captain Charles E. Cross, of Company B, was killed, June 5, 1863, at Franklin's Crossing of the Rappahannock, near Fredericksburg.

The battalion's work as pioneers was always coincident with the movements of the Army, the repair or construction of roads and trestle or crib bridges being interrupted only when the necessity arose for pontoon bridges across streams impracticable of fording. In many of its battles and in the sieges of Yorktown and Petersburg, the battalion served as sappers or miners, actually executing much of the more important work and generally supervising or instructing troops of the line in the construction of the remainder. Almost the entire line in front of Yorktown was in charge of Duane and the officers and men of the battalion, and at Petersburg the construction, repair, and strengthening of the lines from the Appomattox to Hatcher's Run were under its immediate care.

After the conclusion of hostilities by the surrender of Lee on April 9, 1865, the battalion on May 1, 1865, proceeded by rail to City Point and then marched to Washington in advance of the Army of the Potomac, repairing the bridges and roads for its march to the capital. On May 23 it took part in the grand review as a part of the Army of the Potomac. In June Companies A, B, and D were transferred to Willets Point for station, and a few days later Company A was assigned to West Point. Company C remained in Washington until December, receiving and forwarding to Willets Point for storage the immense engineer trains and supplies of the Army and then joined companies B and D.

STAFF DUTIES OF ENGINEER OFFICERS

The services rendered by the Engineer Battalion and by the officers attached to it were arduous, efficient, and gallant, but they formed only a minor part of the duties accomplished during the Rebellion by the entire Corps of Engineers. The requirements of the battalion absorbed but a small proportion of the commissioned strength of the corps, and much the larger part of its officers served on staff duty or in command of troops of the line. Coming out of the War as a single corps, these services of its officers as individuals will be recorded together and not under the heads of the two organizations with which the war began.

As staff engineers the officers of the corps directed the engineer work of the war from the positions held by them at headquarters of the various Armies and smaller units, and in addition, they served in many other important and confidential staff capacities. In numerous instances, while holding the rank only of subalterns, they performed staff duties of the highest importance to the higher commanders and had the direction and control, amounting practically to the command, of large bodies of troops.

The value of staff services is never a matter of exact or complete record nor is it capable of being publicly recognized in the results accomplished although to all military men it is well known. The reward for such services is ordinarily to be found in the commendations of commanding officers which become of public record in promotions or by brevets for services rendered. Often staff services lead directly to the command of troops. This is well illustrated by the career of Maj. Gen. J. B. McPherson, an Engineer officer. The skill and ability of this officer, both as an engineer and in command of troops, became evident to General Grant soon after McPherson's assignment to the latter's staff early in 1862. A period of but 3 months upon staff duty was followed by his promotion to brigadier general of volunteers and assignment to command, the real beginning of his invaluable war service. On the other hand the character, value, and appreciation of staff services as such is markedly evident in the case of another engineer officer, J. B. Comstock, who while aide de camp to General Grant in 1864–5, rendered services whose importance and character are in no wise indicated by his nominal staff assignments but are privately known in their real worth and were compensated by six brevets, including the grades of brigadier general in the Army and major general in the volunteers.

SUMMARY OF SERVICES

The services of individual officers were so varied during the 4 years of the war that it is impracticable in this sketch to write even a summary of individual records or to enter into the details of the various staff duties performed. There will be found in a later paragraph, a short statement of the brevets received by engineer officers for war services of all kinds performed during the conflict, and it may be added here that while on staff duty three engineers were killed and two were mortally wounded.

The bare facts relating to the records of engineer officers from 1861 to 1865 are however, readily summarized from official sources. The official registers show the names of 117 officers who held commissions in the Corps of Engineers, or Corps of Topographical Engineers, during the years named, omitting only those who resigned before the opening of hostilities to join the Confederacy and the graduates from the class of 1865 from the Military Academy who received their commissions after active operations ceased. Twenty-three of these officers saw no field service during the war, mainly by reason of age or physical disability, and of them two died and six were retired during the period of hostilities. Ninety-four officers served in active field operations during all or some part of the war, and among them occurred the following casualties:

Killed in action (Cross, McPherson, J. R. Meigs, Morton, O'Rorke, and Putnam)	6
Mortally wounded (Dutton, J. L. Kirby Smith, Wagner, and Whipple)	4
Killed accidentally in line of duty (Cantwell and Hunt)	2
Wounds, not mortal (Abbot, Franklin, R. S. MacKenzie (3 times), Meade, Merrill, Morton, Prime, Tower, Warren (twice), and Wright (twice)	14
Captured	6
Died (in addition to 2 who were not in the field)	5
Total war casualties	37

Upon these 94 officers were conferred 188 brevets for gallant and meritorious conduct on specified occasions, an average of two brevets each. Of such brevets, Comstock received 6; Ronald S. MacKenzie, J. H. Wilson, and J. M. Wilson, 5 each; Abbot, Dutton, Foster, Gillmore, McAlester, Merrill, Michie, O'Rorke, Parke, Poe, Reese, J. L. Kirby Smith, Weitzel, Whipple, and Wright (15), 4 each; and 14, 23, 18, and 20 officers received 3, 2, 1, and none each, respectively.

Among the officers serving in the field who received no brevets were McPherson and Meade, one of whom was killed and the other wounded and who were rewarded by direct promotion; Meigs, who became Quartermaster General in 1861; two who died within 3 months of being commissioned; five who apparently were never in action; and 3 who were in the field but a short period in 1862.

In addition to brevets for services on specified occasions there were received by 59 officers, 90 brevets for gallant, meritorious or faithful services during the war or during a particular campaign. Of these brevets, 5 officers received 3 each, 21 officers received 2 each, and 33 officers received one each.

Of brevets of all kinds there were received by engineer officers a total of 278 for Civil War services, distributed among 99 officers, an average of nearly 3 brevets each and an average of fully 3 brevets if the mean commissioned strength during the entire war period be considered. Among these brevets were 29 to the grade of major general, 44 to the grade of brigadier general, and 55 to the grade of colonel.

Of honors of a higher order there were received by the Engineers at least their full share. Benyaurd, Gillespie, and J. M. Wilson were awarded Congressional Medals of Honor. McPherson had the rare distinction, in addition to his ability as an engineer and as a general officer, of having been awarded a Medal of Honor by the officers of his Army Corps (17th) for the gallantry with which he led them during the campaign and siege of Vicksburg.

Gillmore, Ronald S. MacKenzie, and Warren received commissions for distinguished services: Gillmore "for the distinguished skill, ability, and gallantry displayed in the operations under his charge in Charleston Harbor; the descent upon Morris Island; the reduction of Fort Sumter and the taking of Fort Wagner and Battery Gregg"; MacKenzie "for gallant and meritorious services in the battles of Opequan, Fisher's Hill, and Middletown, Va."; and Warren "for distinguished conduct in the battle of Gaines' Mill."

Meade, by resolution of January 28, 1864, received the thanks of Congress upon the success of the army under his command at Gettysburg.

COMMANDS HELD BY ENGINEER OFFICERS DURING THE CIVIL WAR

Staff services of high orders are invaluable and indispensable to success in military operations but they frequently indicate a different order of talent and are recognized and rewarded upon a plane entirely different from that assigned to equally meritorious and successful services in command of troops. The greatest prominence during the Civil War was attained consequently by those officers of the corps who had confided to them the command of troops under commissions in the Army or the Volunteers. So far as is known none of them held such command by virtue of their commissions as engineer officers other than with the Battalion of Engineers of the Regular Army, all other cases being concerned with line commands of troops usually of other arms of the service.

From the earliest days of the war engineer officers held command of troops, with a steady increase to the end of the war in the number, variety, and importance of such duties. The troops commanded in the field included all branches of the service, infantry, cavalry, artillery, and engineers, as well as divisions, corps, and armies involving the combined operations of all arms. The merit with which these commands were exercised will be considered hereafter in this sketch. The bare facts relating to them will alone be given here and will after the manner of statistics indicate by even casual consideration the recognition given to officers who held command during the Civil War.

Fourteen engineer officers were appointed to the command of regiments; 12 in the Volunteers and 2 in the Regular Army (Meigs to the 11th Infantry and Franklin to the Twelfth Infantry). Eleven of these assignments were to infantry regiments in 1861 and 1862; 2 to artillery in 1863 and 1864; and 1 to an engineer regiment in 1864. Of the officers commanding infantry regiments, 4 were killed or mortally wounded leading their troops; J. L. Kirby Smith at Corinth, O'Rorke at Gettysburg, Putnam at Bermuda, Hundred, and Dutton at Fort Wagner. None of these 4 were more than 27 years of age. Of the other seven, 5 became general officers. One (Simpson) resigned his command in 1862. Abbot, appointed to an artillery regiment in 1863, served with it with distinction to the end of the war particularly during the siege of Petersburg, and Ronald S. MacKenzie appointed in 1864 became a brigadier general 3 months later. Merrill was given the command of an engineer regiment in July 1864 and retained it until the end of the war. Among the 14 officers commanding regiments, 3 held in the engineers at the time of appointment the grade of second lieutenant; 4 held the grade of first lieutenant, 6 the grade of captain, and 1 the grade of major. All the 7 lieutenants but 1 were killed or became brigadier generals and 4 of the captains reached the same grade, followed in 3 cases by subsequent promotion. Judging from this record an engineer lieutenant who succeeded in attaining the command of a regiment of volunteer infantry in this protracted struggle, had 6 chances out of 7 of becoming a general officer or of laying his life upon the altar of his country. Twenty-three engineer officers reached the grade of brigadier general, 22 in the Volunteers and 1 (Meigs) in the Regular Army without passing through the Volunteers. Eleven were appointed in 1861, 10 in 1862, and 1 each in 1863 and 1864. One was from the grade of first lieutenant in the engineers, 12 from the grade of captain, 8 from the grade of major, and 1 from the grade of colonel. Of the 22 volunteer appointments, 1 was not confirmed, 1 died in the service, 1 (Morton) was mustered out of the volunteers in a year and subsequently killed in action, 15 became major generals of Volunteers, and 4 retained the grade to the end of the war, receiving from 3 to 7 brevets each. Eleven of the 12 captains became major generals of Volunteers and 4 of the 8 majors, 1 major dying while holding the grade of brigadier general.

Fifteen officers reached the grade of major general of Volunteers, all by promotion from the next lower grade under the test of war service. Eight were appointed in 1862, five in 1863, one in 1864, and one in 1865, and when so appointed, nine were captains of Engineers and five were majors. The fifteenth (Franklin) was promoted in 1861 from captain of Engineers to colonel of Infantry. Two were killed or mortally wounded—Whipple at Chancellorsville and McPherson at Atlanta. Three became brigadier generals in the Regular Army during the war—McPherson, Meade, and Pope—in addition to Meigs, who became Quartermaster General in 1861. Meade reached the grade of major general in the Regular Army in 1864.

After the close of the war and as a result of war services, Pope became major general in the Regular Army; J. H. Wilson, lieutenant colonel of Infantry; Ronald S. MacKenzie, colonel of Infantry and of Cavalry and subsequently brigadier general.

The variety and importance of the commands held by the above officers, when taken in connection with the regular and steady promotion awarded to them, affords the best evidence of the value of their wartime services. The 14 regimental commands have been previously stated. Sixteen officers commanded brigades of Engineers or Infantry, nearly all being of Infantry. Twelve officers commanded Infantry divisions and two (J. H. Wilson and Ronald S. MacKenzie) commanded Cavalry divisions. Twelve officers (Foster, Franklin, Gillmore, Humphreys, McPherson, Meade, Newton, Parke, W. F. Smith, Warren, Weitzel, and Wright) commanded Army corps by permanent assignment, and one (J. H. Wilson) commanded a Cavalry corps. Abbot commanded the heavy artillery of the entire force engaged in the siege of Petersburg.

Meade commanded the Army of the Potomac during the last 2 years of the war; Pope the Army of the Mississippi in its operations on the Mississippi and against Corinth early in 1862 and the Army of Virginia in the summer of the same year; and McPherson the Army of the Tennessee in the Atlanta campaign until his death, July 22, 1864, being second in command to General Sherman. Foster commanded in North Carolina during the operations of 1862–63; Gillmore in the operations against Charleston in 1863–64, resulting in the capture of Fort Wagner and the reduction of Fort Sumter; Weitzel all of the troops north of the Appomattox River in the final operations against General Lee's army in the spring of 1865, including the occupation of Richmond; J. H. Wilson the highly successful cavalry expedition into Alabama and Georgia in March and April 1865; and Meigs performed the duties of Quartermaster General of the Army throughout the war with the highest efficiency, taking the field to direct personally the operations of his department at critical stages, such as the investment of Chattanooga in 1863 and during General Grant's overland campaign against Richmond in 1864. Numerous other Engineer officers on many occasions of less importance held the command of territorial districts, departments, or divisions. As a whole the officers of the corps holding commands acquitted themselves with gallantry and distinction worthy of the cause and service which they represented.

CIVIL WAR SERVICES IN THE UNION ARMY OF FORMER OFFICERS OF THE CORPS OF ENGINEERS

In addition to the engineer officers who served in the Civil War under or while retaining their regular commissions as such, many former officers of the Corps of Engineers or the Corps of Topographical Engineers who had been transferred to other branches of the Army or who had resigned their commissions prior to the war served with distinction in the Union Army. These men were:

George L. Andrews.
William H. C. Bartlett.
William H. Emory.
Henry C. Eustis.
Joseph K. F. Mansfield.
George B. McClellan.
George W. Morell.
Thomas H. Ruger.
Eliakim P. Scammon.
John C. Fremont.
Henry W. Halleck.
Rufus King.
Thomas J. Leslie.
Isaac I. Stevens.
William S. Rosecrans.
Joseph D. Webster.
Thomas J. Wood.

Of these 17 officers, 2 saw no field service—Bartlett being a professor at the Military Academy and Leslie serving in New York throughout the war as an officer of the pay department to which he had been transferred in 1838. The other 15 all held rank as general officers, 2 being commissioned brigadier generals in the Regular Army, and 10 others in the Volunteers. Three became major generals in the Regular Army and 6 major generals in the Volunteers.

Mansfield entered the war as colonel and inspector general; Emory and Wood as lieutenant colonel and major of the First Cavalry, respectively; Mansfield and Rosecrans were appointed brigadier generals in the Regular Army in 1861, the latter having resigned in 1854 and reentered the service as colonel of Ohio Volunteer Infantry; Fremont, Halleck, and McClellan were appointed major generals in the Regular Army from civil life in 1861, all of them having resigned from the service between the Mexican and Civil Wars. Andrews, Eustis, Ruger, Stevens, and Webster became colonels of Volunteer Infantry in 1861–62, and Morell a staff colonel of Volunteers in 1861; all became brigadier generals of Volunteers in 1861–62, excepting Eustis, who reached that grade in 1863. Mansfield, Morell, Rosecrans, and Stevens became major generals of Volunteers in 1862; Emery and Wood in 1865.

INDEX

Page
Forward -- III
Introduction--- 1
The Engineers during the revolution--------------------------- 3
The post-revolutionary period-------------------------------- 6
The organization of the Corps of Engineers and the Military Academy----- 10
The Engineers in the War of 1812----------------------------- 14
Officers of the Corps of Engineers in the War of 1812------------- 17
From 1812 to 1846--- 23
The Engineers in the War with Mexico-------------------------- 26
Officers of the Corps of Engineers who served in the field during the War with Mexico-- 30
From 1848 to 1861--- 31
The consolidation of 1863------------------------------------ 32
The Corps of Topographical Engineers-------------------------- 33
The Topographical Engineers in the Mexican War----------------- 41
Officers of the Corps of Topographical Engineers who served in the field during the War with Mexico------------------------------- 41
From 1848 to 1861--- 43
The Civil War--- 43
Operations of the Battalion of Engineers in the Civil War------------ 44
Staff duties of Engineer officers------------------------------- 46
Summary of services-- 47
Commands held by Engineer officers during the Civil War----------- 48
Civil War services in the Union Army of former officers of the Corps of Engineers-- 51

○

Year	Month	Element	Dates	Station
1932	March	Regiment less Companies B, F, and Band.	1-16	Fort Du Pont, Del.
			17	En route to Camp Dix, N. J.
			18-31	Camp Dix, N. J.
		Band	1-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	April	Regiment less Companies B, F, and Band.	1-30	Camp Dix, N. J.
		Band	1-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	May	Regiment less Companies B, F, and Band.	1-31	Camp Dix, N. J.
		Band	1-30	Fort Du Pont, Del.
			31	Camp Dix, N. J.
		Companies B and F		Inactive.
	June	Regiment less Companies B and F.	1-30	Camp Dix, N. J.
		Companies B and F		Inactive.
	July	Regiment less Companies B and F.	1-12	En route to Ocean City, N. J.
			13-14	Ocean City, N. J.
			15-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	August	Regiment less Companies B and F.	1-31	Fort Du pont, Del.
		Companies B and F		Inactive.
	September	Regiment less Companies B, E, and F.	1-30	Fort Du Pont, Del.
		Company E	1-20	Do.
			21-30	En route to Fort Benning, Ga.
		Companies B and F		Inactive.
	October	Regiment less Companies B, E, and F.	1-31	Fort Du Pont, Del.
		Company E	1- 3	En route to Fort Benning, Ga.
			4-31	Fort Benning, Ga.
		Companies B and F		Inactive.
	Nov. 1 to Feb. 28	Regiment less Companies B, E, and F.		Fort Du Pont, Del.
1933		Company E		Fort Benning, Ga.
		Companies B and F		Inactive.
	March	Regiment less Companies B, E, F, and Band.	1-30	Fort Du Pont, Del.
			31	Camp Dix, N. J.
		Company E	1- 5	Fort Benning, Ga.
			6-16	En route to Fort Du Pont, Del.
			17-30	Fort Du Pont, Del.
			31	Camp Dix, N. J.
		Band	1-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	April	Regiment less Companies B, F, and Band.	1-30	Camp Dix, N. J.
		Band	1-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	May 1 to June 30	Regiment less Companies B, F, and Band.		Camp Dix, N. J.
		Band		Fort Du Pont, Del.
		Companies B and F		Inactive.
	July	Regiment less Companies B, F, and Band.	1- 2	Camp Dix, N. J.
			3	En route to Fort Du Pont, Del.
			4-31	Fort Du Pont, Del.
		Band	1-31	Do.
		Companies B and F		Inactive.
	August	Regiment less Companies B, F, and Band.	1-31	Fort Du Pont, Del.
		Band	1-31	Camp Dix, N. J.
		Companies B and F		Inactive.
	September	Regiment less Companies B, F, and Band.	1-30	Fort Du Pont, Del.
		Band	1- 4	Camp Dix, N. J.
			5-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	Oct. 1 to Feb. 28	Regiment less Companies B and F.		Fort Du Pont, Del.
1934		Companies B and F		Inactive.
	March	Regiment less 1st Battalion and Companies D and F.	1-31	Fort Du Pont, Del.
		1st Battalion (less Company B) and Company D.	1-27	Do.
			28-31	Camp Dix, N. J.
		Companies B and F		Inactive.
	Apr. 1 to Oct. 31	Regiment less 1st Battalion and Companies D and F.		Fort Du Pont, Del.
		1st Battalion (less Company B) and Company D.		Camp Dix, N. J.
		Companies B and F		Inactive.
	November	Regiment less 1st Battalion and Companies D and F.	1-30	Fort Du Pont, Del.
		1st Battalion (less Companies B and C) and Company D.	1-30	Camp Dix, N. J.

Year	Month	Element	Dates	Station
1934	November	Company C	1-26	Camp Dix, N. J.
			27-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	December	Regiment less Companies A, B, D, F, and 1st Battalion Headquarters.	1-31	Fort Du Pont, Del.
		Companies A, D, and 1st Battalion Headquarters.	1-15	Camp Dix, N. J.
			16-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
1935	Jan. 1 to June 30	Regiment less Companies B and F.		Fort Du Pont, Del.
		Companies B and F		Inactive.
	July	Regiment less Companies B, C, and F.	1-31	Fort Du Pont, Del.
		Company C	1-10	Do.
			11-12	En route to Pine Camp, N. Y.
			13-31	Pine Camp, N. Y.
		Companies B and F		Inactive.
	August	Regiment less Companies B, C, D, F, and Headquarters 2d Battalion.	1- 3	En route to Pine Camp, N. Y.
			4-31	Pine Camp, N. Y.
		Company C	1-31	Do.
		Company D and Headquarters 2d Battalion.	1-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	September	Regiment less Companies B, D, F, and Headquarters 2d Battalion.	1- 3	Pine Camp, N. Y.
			4- 5	En route to Fort Du Pont, Del.
			6-30	Fort Du Pont, Del.
		Company D and Headquarters 2d Battalion.	1-30	Do.
		Companies B and F		Inactive.
	October	Regiment less Companies B, D, and F.	1-31	Fort Du Pont, Del.
		Company D	1-28	Do.
			29-31	On practice march.
		Companies B and F		Inactive.
	November	Regiment less Companies B, D, and F.	1-30	Fort Du Pont, Del.
		Company D	1-10	On practice march.
			11-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	Dec. 1 to May 31	Regiment less Companies B and F.		Fort Du Pont, Del.
1936		Companies B and F		Inactive.
	June	Regiment less Companies A, B, and F.	1-30	Fort Du Pont, Del.
		Company A	1-21	Do.
			22-29	Camp Dix, N. J.
			30-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	July 1 to Aug. 31	Regiment less Companies B and F.		Fort Du Pont, Del.
		Companies B and F		Inactive.
	September	Regiment less Companies A, B, D, F; Headquarters 2d Battalion and Band.	1-14	Fort Du Pont, Del.
			15-17	Camp Dix, N. J.
			18-30	Fort Du Pont, Del.
		Company A	1-30	Do.
		Company D	1-15	Do.
			16-30	Pine Camp, N. Y.
		Headquarters 2d Battalion	1-30	Fort Du Pont, Del.
		Band	1-20	Do.
			21-25	Practice march.
			26-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	October	Regiment less Companies B, D, and F.	1-31	Fort Du Pont, Del.
		Company D	1- 6	Pine Camp, N. Y.
			7-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	Nov. 1 to Dec. 31	Regiment less Companies B and F.		Fort Du Pont, Del.
		Companies B and F		Inactive.
1937	Jan. 1 to June 30	Regiment less Companies B and F.		Fort Du Pont, Del.
		Companies B and F		Inactive.
	July	Regiment less Companies A, B, and F.	1-31	Fort Du Pont, Del.
		Company A	1- 7	Do.
			8- 9	En route to Fort Devens, Mass.
			10-31	Fort Devens, Mass.
		Companies B and F		Inactive.
	August	Regiment less Companies A, B, D, and F.	1-31	Fort Du Pont, Del.

Year	Month	Element	Dates	Station
1937	August	Company A	1- 2	Fort Devens, Mass.
			3	En route to Fort Du Pont, Del.
			4-31	Fort Du Pont, Del.
		Company D	1-16	Do.
			17-26	Practice march.
			27-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	September	Regiment less Companies B, C, E, and F.	1-30	Fort Du Pont, Del.
		Company C	1- 3	Do.
			4-14	Maneuvers, Indiantown Gap, Pa.
			15-30	Fort Du Pont, Del.
		Company E	1-15	Do.
			16-30	Maneuvers, Pine Camp, N. Y.
		Companies B and F		Inactive.
	Oct. 1 to Dec. 31	Regiment less Companies B and F.		Fort Du Pont, Del.
		Companies B and F		Inactive.

FIRST ENGINEER TRAIN

The First Engineer Train was organized at Washington Barracks, D. C., June 12, 1917, under the provisions of the Act of Congress approved May 18, 1917, and pursuant to first endorsement Adjutant General's Office 2605788, dated June 9, 1917. Another train of like numerical designation was organized at Leon Springs, Texas, April 4, 1917, and on July 29, 1917, was redesignated Fifth Engineer Train. (See Fifth Engineer Train.)

Year	Month	Element	Dates	Station
1917	June	1st Engineer Train	12–30	Washington Barracks, D. C.
	July	do	1–31	Do.
	August	do	1–6	Do.
			7–20	Embarked on U. S. Army cargo transport *Jacinto*, Hoboken, N. J., and en route to St. Nazaire, France.
			21–31	In camp at St. Nazaire, France.
1919	Sept. 1 to July 31	do		American Expeditionary Forces in France and Germany.
	August	do	1–19	Block-Heimbach, Germany.
			20	En route to Engers, Germany.
			21–24	En route to Brest, France.
			25–31	En route to United States aboard U. S. S. *Edellyn*.
	September	do	1–4	En route to United States aboard U. S. S. *Edellyn*. Landed at Hoboken, N. J., and moved to Camp Mills, N. Y., same day.
		do	5–9	Camp Mills, N. Y.
			10	En route to Washington, D. C.
			11–16	Camp Leach, D. C.
			17	En route to Camp Meade, Md.
			18–30	Camp Meade, Md.
	October	do	1	Do.
			2–3	En route to Camp Zachary Taylor, Ky.
			4–31	Camp Zachary Taylor, Ky.
1920	Nov. 1 to May 31	do		Do.
1921	June 1 to Apr 4	do		No personnel assigned. Demobilized per Change Sheet No. 22, Apr. 4, 1921. Discontinued as a separate organization Jan. 27, 1921, in accordance with T/O 63P.

SECOND ENGINEERS

The Second Regiment of Engineers, except Companies E and F, was organized at Dublen, Mexico, on August 1, 1916, in accordance with the provisions of the act of Congress approved June 3, 1916, and pursuant to War Department Special Order 144, 1916, and General Order 22, War Department, 1916. The Headquarters of the Second Battalion of Engineers became the Headquarters of the Second Regiment of Engineers. Companies E, F, G, and H, Second Battalion of Engineers, became respectively Companies C, F, A, and B of the Second Regiment of Engineers. Company D, Second Regiment of Engineers, was formed by transfers from Companies E, G, and H, Second Battalion of Engineers. Company E, Second Regiment of Engineers, was formed at Vancouver Barracks, Wash., July 1, 1916, by transfers from Company F, Second Regiment of Engineers.

Year	Month	Element	Dates	Station
1916	July	Headquarters, 2d Battalion	1-31	Vancouver Barracks, Wash.
		Company E	1- 4	Do.
			5-31	En route to and at Calexico, Calif.
		Company F	1-31	Vancouver Barracks, Wash.
	Aug. 1 to Oct. 31	Regiment less Headquarters 2d Battalion, Companies E and F.		With punitive expedition Mexico.
		Headquarters 2d Battalion and Company F.		Vancouver Barracks, Wash.
		Company E		Calexico, Calif.
	November	Regiment less Headquarters 2d Battalion, Companies E, F.	1-30	With punitive expedition Mexico.
		Headquarters 2d Battalion and Company F.	1-30	Vancouver Barracks, Wash.
		Company E	1- 2	Calexico, Calif.
		Company E	3-20	Fort Barry, Calif.
			21-23	Enroute to Vancouver Barracks, Wash.
			24-30	Vancouver Barracks, Wash.
	Dec. 1 to Jan. 31	Regiment less Headquarters 2d Battalion, Companies E and F.		With punitive expedition Mexico.
1917		2d Battalion less Company D		Vancouver Barracks, Wash.
	February	Regiment less Headquarters 2d Battalion, Companies E and F.	1- 4	With punitive expedition Mexico.
			5	En route from Palomas, Mexico, to Columbus, N. Mex.
			6- 7	Columbus, N. Mex.
			8- 9	En route to Camp Stewart, El Paso, Tex.
			10-28	Camp Stewart, El Paso, Tex.
		2d Battalion less Company D	1-28	Vancouver Barracks, Wash.
	March	Regiment less Headquarters 2d Battalion, Companies E and F.	1-12	Camp Stewart, El Paso, Tex.
			13-31	Camp Newton D. Baker, El Paso, Tex.
		2d Battalion less Company D	1-31	Vancouver Barracks, Wash.
	April	Regiment less Headquarters 2d Battalion, Companies E and F.	1-30	Camp Newton D. Baker, El Paso, Tex.
		2d Battalion less Company D	1-30	Vancouver Barracks, Wash.
	May	Regiment less Headquarters 2d Battalion, Companies E and F.	1-20	Camp Newton D. Baker, El Paso, Tex.
		2d Battalion less Company D	1-20	Vancouver Barracks, Wash.
		Regiment	21-31	Camp Newton D. Baker, El Paso, Tex.

NOTE.—Regiment reorganized May 31, 1917, in accordance with the provisions of War Department General Order No. 62, 1917. Companies A and B were organized into the 2d Regiment of Engineers at El Paso, Tex. Companies E and F, 2d Engineers were organized into the 4th Regiment of Engineers at Vancouver Barracks, Wash. Companies C and D, 2d Engineers, were organized into the 5th Regiment of Engineers at El Paso, Tex.

Year	Month	Element	Dates	Station
1917	June 1 to July 31	Regiment		Camp Newton D. Baker, El Paso, Tex.
	August	do	1-21	Do.
			22-28	En route to Washington, D. C.
			29-31	Camp American University, D. C.
	September	do	1- 9	Do.
			10-13	Aboard R. M. S. *Carpathia* enroute to Halifax, Nova Scotia.
			14-20	Aboard R. M. S. *Carpathia*, Halifax, Nova Scotia.
			21-31	Aboard R. M. S. *Carpathia* enroute to Glasgow, Scotland.
	October	do	1	Do.
			2	Disembarked and en route to Southampton, England.
			3- 4	Southampton, England.
			5- 6	En route to Havre, France.
			7-31	With American Expeditionary Force in France.
1919	Nov. 1 to June 30	do		With American Expeditionary Force in France and Germany.
	July	Regiment less 1st Battalion	1-20	Engers, Germany.
			21-23	En route to Brest, France.
			24-31	Camp Pontaneran, Brest, France.
		1st Battalion	1-18	Engers, Germany.
			19-22	En route to Brest, France.
			23-24	Camp Pontanezan, Brest, France.
			25-31	Aboard U. S. S. *Finland* en route to United States.
	August	Regiment less 1st Battalion	1- 8	Aboard U. S. S. *Great Northern* en route to Hoboken, N. J.
			9-11	Camp Mills, Long Island, N. Y.
			12-14	En route to Camp Travis, Tex.
			15-31	Camp Travis, Tex.
		1st Battalion	1- 5	Aboard U. S. S. *Finland* en route to Hoboken, N. J.
			6-10	Camp Mills, Long Island, N. Y.
			11-14	En route to Fort Riley, Kans.
			15-31	Fort Riley, Kans.
1920	Sept. 1 to Apr. 30	Regiment less 1st Battalion		Camp Travis, Tex.
		1st Battalion		Fort Riley, Kans.
	May	Regiment less 1st Battalion	1-31	Camp Travis, Tex.
		1st Battalion	1-26	Fort Riley, Kans.
			27-29	En route to Camp Travis, Tex.
			30-31	Camp Travis, Tex.
	June 1-Aug. 30	Regiment		Do.
	September	do	1- 3	Do.
			4-29	Camp Bullis, Tex.
			30	Camp Travis, Tex.
1921	Oct. 1 to Jan. 31	do		Do.

NOTE.—By authortiy contained in letter of Jan. 21, 1921, from Commanding General, 2d Division, Camp Travis, Tex., the 2d Engineers is ordered reorganized as per Table of Organization, Combat Engineer Regiment, table No. 63-W dated Dec. 13, 1920. The 2d Engineer Train was absorbed into the Regimental Headquarters and Supply Company 2d Engineers, Jan. 27, 1921. The records of the 2d Engineer Train forwarded to the Adjutant General on Feb. 7, 1921, by the Commanding Officer, 2d Engineers.

February	Regiment	1-28	Camp Travis, Tex.
March	Regiment less 1st Battalion	1-31	Do.
	1st Battalion	1-31	Camp Bullis, Tex.
April	Headquarters and Hq. & Sup. Company F.	1-30	Camp Travis, Tex.
	1st Battalion	1-15	Camp Bullis, Tex.
		16-30	Camp Travis, Tex.
	2d Battalion	1-15	Do.
		16-30	Camp Bullis, Tex.
May	Regiment less 2d Battalion	1-31	Camp Travis, Tex.
	2d Battalion	1-17	Camp Bullis, Tex.
		18-31	Camp Travis, Tex.
June	Regiment	1-15	Do.
		16-30	Camp Bullis, Tex. (target practice).
July	do	1-19	Camp Bullis, Tex.
		20-31	Camp Travis, Tex.
August	do	1-31	Do.
September	Regiment less Company F	1-30	Do.
	Company F	1-27	Do.
		28-30	Camp Bullis, Tex.
October	Regiment less Company F	1-31	Camp Travis, Tex.
	Company F	1- 7	Camp Bullis, Tex.
		8-31	Camp Travis, Tex.

Year	Month	Element	Dates	Station
1921	November	Regiment	1–2	Camp Travis, Tex.
			3–22	Camp Bullis, Tex. (supplementary target practice).
			23–30	Camp Travis, Tex.
1922	Dec. 1 to Feb. 28	do		Do.
	March	do	1–19	Do.
			20–31	Camp Bullis, Tex. (rifle practice).
	April	do	1–30	Do.
	May	do	1–5	Camp Bullis, Tex.
			6–30	Camp Travis, Tex.
	June 1 to Aug. 31	do	1–30	Do.
	September	Regiment less Company E	1–30	Do.
		Company E	1–17	Do.
			18–30	Fort Sam Hoston, Tex.
	October	Regiment less Companies B and E.	1–29	Camp Travis, Tex.
			29–31	Camp Bullis, Tex.
		Company B	1–31	Camp Travis, Tex.
		Company E	1–31	Fort Sam Houston, Tex.
	November	Regiment less Company E	1–24	Camp Bullis, Tex.
			25–30	Camp Travis, Tex.
		Company E	1–30	Fort Sam Houston, Tex.
	Dec. 1 to Feb. 28	Regiment less Company E		Camp Travis, Tex.
1923		Company E		Fort Sam Houston, Tex.
	March	Regiment less Company E	1–12	Do.
			13–31	Camp Bullis, Tex.
		Company E	1–31	Fort Sam Houston, Tex.
	April	Regiment less Company E	1–30	Camp Bullis, Tex.
		Company E	1–30	Fort Sam Houston, Tex.
	May	Regiment less Company E	1–4	Camp Bullis, Tex.
			5–31	Fort Sam Houston, Tex.
		Company E	1–31	Do.
	June	Regiment	1–30	Do.
	July	Regiment less Company C	1–31	Do.
		Company C	1–12	Do.
			13–31	Camp Mabry, Austin, Tex.
	August	Regiment less Company C	1–31	Fort Sam Houston, Tex.
		Company C	1–17	Camp Mabry, Austin, Tex.
			18–31	Fort Sam Houston, Tex.
	Spetember	Regiment	1–30	Do.
	October	Regiment less Company E	1–14	Do.
			15–26	Camp Bullis and Camp Stanley, Tex.
		Regiment less Companies E, B, and C.	26–31	Fort Sam Houston, Tex.
		Companies B and C	26–31	Camp Bullis, Tex.
		Company E	1–31	Fort Sam Houston, Tex.
	November	Regiment less Companies B and C.	1–30	Do.
		Companies B and C	1–25	Camp Bullis, Tex.
			26–30	Fort Sam Houston, Tex.
1924	Dec. 1 to Apr. 30	Regiment		Do.
	May	Regiment less Company E	1–14	Do.
		Hq. & Sup. Company, Companies B and C.	15–27	Camp Bullis, Tex.
		Company A	15–31	Do.
		Companies D and F	16–27	Do.
		Regiment less Companies A and E.	28–31	Fort Sam Houston, Tex.
		Company E	1–31	Do.
	June	Regiment less Companies A and B.	1–30	Do.
		Company A	1–30	Sub-Post Camp Bullis, Tex.
		Company B (less 1 platoon)	1–21	Fort Sam Houston, Tex.
			21–30	Fort Crockett, Tex.
	July	Regiment less Companies A and B.	1–31	Fort Sam Houston, Tex.
		Company A	1–15	Sub-Post Camp Bullis, Tex.
			16–31	Fort Sam Houston, Tex.
		Company B (less 1 platoon)	1–21	Fort Crockett, Tex.
			22–31	Fort Sam Houston, Tex.
1925	Aug. 1 to Apr. 30	Regiment		Do.
	May	Regiment less Company E	1–3	Do.
			4–16	Practice march.
			17–31	Fort Sam Houston, Tex.
		Company E	1–31	Do.
	June 1 to July 31	Regiment		Do.

Year	Month	Element	Dates	Station
1925	August	Regiment less Companies D and E.	1-3	Fort Sam Houston, Tex.
			4-31	Camp Bullis, Tex.
		Companies D and E	1-31	Fort Sam Houston, Tex.
	September	Regiment less Companies B, D, and E.	1-9	Camp Bullis, Tex.
			10-30	Fort Sam Houston, Tex.
		Company B	1-9	Camp Bullis, Tex.
			10-30	Camp Stanley, Tex.
		Company D	1-9	Fort Sam Houston, Tex.
			10-30	Camp Bullis, Tex.
		Company E	1-30	Fort Sam Houston, Tex.
	October	Regiment less Companies B and D.	1-31	Do.
		Company B	1-31	Camp Stanley, Tex.
		Company D	1-13	Camp Bullis, Tex.
			14-31	Fort Sam Houston, Tex.
	November	Regiment less Company B	1-30	Do.
		Company B	1-11	Camp Stanley, Tex.
			12-30	Fort Sam Houston, Tex.
1926	Dec. 1 to Feb. 28	Regiment	--------	Do.
	March	Regiment less Company A	1-31	Do.
		Company A	1-6	Do.
			7-31	Camp Bullis, Tex.
	April	Regiment	1-30	Fort Sam Houston, Tex.
	May	Regiment less Companies A and E.	1-11	Do.
			12-29	Practice march.
			30-31	Fort Sam Houston, Tex.
		Companies A and E	1-31	Do.
	June	Regiment less 1st Battalion	1-30	Do.
		1st Battalion	1-6	Do.
			7-30	Camp Stanley, Tex.
	July	Regiment less 1st Battalion	1-31	Fort Sam Houston, Tex.
		1st Battalion	1-9	Camp Stanley, Tex.
			10-25	Fort Sam Houston, Tex.
			26-31	Camp Stanley, Tex.
	August	Regiment less Companies A, B, and C.	1-17	Fort Sam Houston, Tex.
			18-31	Camp Bullis, Tex.
		Companies A, B, and C	1-17	Camp Stanley, Tex.
			18-31	Camp Bullis, Tex.
	September	Regiment less Company E	1-17	Do.
			18-28	Fort Sam Houston, Tex.
			29-30	Camp Stanley, Tex.
		Company E	1-30	Fort Sam Houston, Tex.
	October	Regiment less Company E	1-25	Camp Stanley, Tex.
			25-31	Fort Sam Houston, Tex.
		Company E	1-31	Do.
1927	Nov. 1 to Apr. 30	Regiment	------	Do.
	May	do	1	Do.
			2-23	Maneuvers, Camp Stanley and Camp Bullis, Tex.
			24-31	Construction, Camp Stanley and Camp Bullis, Tex.
	June	do	1-14	Fort Sam Houston, Tex.
		1st Battalion and detachment of Hq. & Serv. Company.	15-17	En route to Fort Logan, Colo.
			18-30	Fort Logan, Colo.
		2d Battalion and detachment of Hq. & Serv. Company.	15-17	En route to Fort Sam Houston, Tex.
			18-20	En route to Fort Logan, Colo.
			21-30	Fort Logan, Colo.
		NOTE.—The Hq. & Serv. Company moved to Fort Logan in two groups.		
	July	Regiment	1-31	Do.
	August	Regiment less 2d Battalion	1-31	Do.
		2d Battalion	1-2	Do.
			2-26	Parker, Colo.
			27-31	Fort Logan, Colo.
	September	Regiment less 1st Battalion and Hq. & Serv. Company.	1-30	Do.
		1st Battalion and Hq. & Serv. Company.	1-24	Golden, Colo.
			25-30	Fort Logan, Colo.
1928	Oct. 1 to July 31	Regiment	--------	Do.
	August	Regiment less 1st Battalion	1-31	Do.
		1st Battalion	1-14	Do.
			15-31	Golden, Colo.

STATIONS
OF ENGINEER UNITS
REGULAR ARMY
1846–1937

Number 70, Occasional Papers
The Engineer School, United States Army
June 1938

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON: 1938

INTRODUCTION

In January 1929 the Engineer School published a pamphlet entitled "Stations of Engineer Units, Regular Army, 1866–1921." That pamphlet proved very useful as a ready reference in connection with inquiries regarding the stations of Regular Army Engineer units of definite periods during former years.

After several years use, however, the pamphlet was found to contain numerous discrepancies and, because of its historical value and the need for such data, it was decided to undertake a revision of the pamphlet.

Soon after research work was undertaken, it was discovered that with little additional effort the stations of Regular Army Engineer units could be established from original sources back as far as 1846, the earliest date from which continuity of organization of any present-day unit could be established and the earliest date at which units of strictly engineer soldiers could be identified. As a result, the data contained herein pertaining to all active Regular Army Engineer units and covering the period from June 1846 to December 31, 1937, have been made available.

Original documents only have been used as source material; unit, station, and expedition returns, muster rolls, general and special orders, rosters, and ship manifests were checked and used in this compilation.

This document accounts for practically every day of service of all active Regular Army Engineer units existing between June 1846 and December 1937, except for the periods during which those units participated in the Punitive Expedition into Mexico and the American Expeditionary Forces in France.

The units participating in the Punitive Expedition of 1916 are so indicated for the period of departure from, and reentry into, the United States, however, and those which served with the American Expeditionary Forces in France are so indicated from the time of debarkation in France to the time of embarkation for return to the United States. These exceptions have been made due to the innumerable movements of the various components of the units under the stress of active campaign.

DEPOSITED BY THE
UNITED STATES OF AMERICA
JAN 10 '39

COMPANY A, SAPPERS, MINERS, AND PONTONIERS

Company A of Engineers authorized by General Order 14, Adjutant General's Office 1846, was organized as a Company of Sappers, Miners, and Pontoniers at the United States Military Academy, West Point, N. Y., in June 1846, with Capt. Alexander J. Swift in command.

Year	Month	Element	Dates	Station
1846	June	Company A	-30	West Point, N. Y.
	July 1 to Aug. 31	do		Do.
	September	do	1-23	Do.
			24	Boarded ship *Clinton* at New York bound for Brazos, Santiago, Tex., to join General Taylor's Army in Mexico.
			25	Dropped down to the lower roads.
			26	Put to sea.
			27-30	At sea.
	October	do	1-11	En route to Brazos, Santiago, Tex.
			12-16	Brazos, Santiago, Tex.
			17-18	En route to Matamoros.
			19-28	Matamoros, Mexico.
			29-31	En route to Camargo, Mexico.
	November	do	1-30	At Camargo, Mexico, and en route by water to the mouth of the Rio Grande.
	December	do	1- 5	En route from Camargo, Mexico. Landed at the mouth of the Rio Grande on the 5th.
			6- 7	At the mouth of the Rio Grande.
			8	Embarked and landed at Matamoros.
			9-20	Matamoros, Mexico.
			21-30	Marching to Santander, Mexico.
			31	Santander, Mexico.
1847	January	do	1-23	Marching to Tampico, Mexico.
			24-31	Tampico, Mexico.
	February	do	1-24	Do.
			25	Sailed from Tampico, Mexico.
			26	Arrived off Lobos Island.
			27-28	Aboard ship off Lobos Island.
	March	do	1- 8	Do.
			9	Landed at Vera Cruz, Mexico.
			10-31	Camp Washington near Vera Cruz, Mexico.
	April	do	1-12	Camp Washington near Vera Cruz, Mexico.
			13	Marched from Vera Cruz, flogged the enemy on the 18th, and arrived at Tepe Aqualco, Mexico, on the 27th.
			28-29	Tepe Aqualco, Mexico.
	May	do	1- 9	Do.
			10-15	En route to Puebla, Mexico.
			16-31	Puebla, Mexico.
	June 1 to July 31	do		Do..
	August	do	1- 6	Do.
			7	Left Puebla en route for the City of Mexico. Conquered the enemy in 2 pitched battles on the 20th, and arrived at San Angels, Mexico, on the 21st.
			22-31	San Angels, Mexico.
1848	Sept 1 to Apr. 30	do		City of Mexico.
	May	do	1-27	Do.
			28-31	En route to Acazingo, Mexico.
	June	do	1-23	En route from Acazingo, Mexico, to West Point, N. Y.
			24-30	West Point, N. Y.

Year	Month	Element	Dates	Station
1848 1858	July 1 to Mar. 31	Company A		West Point, N. Y.
	April	do	1–30	Fort Leavenworth, Kans.
	May	do	1– 5	Do.
			6–31	En route to Utah Territory.
	June	do	1–30	En route to Utah Territory. (At Camp No. 45 near Medicine Bow Butte, June 30, 1858.)
	July	do	1–31	En route to Fort Bridger, Utah Territory.
	August	do	1– 8	Fort Bridger, Utah Territory.
			9–31	En route to West Point, N. Y. (At Camp No. 20, near Fort Laramie on Aug. 31, 1858.)
	September	do	1–30	En route to West Point, N. Y.
	October	do	1–13	Do.
			14–31	West Point, N. Y.
1860	Nov. 1 to Dec. 31	do		Do.
1861	January	do	1–17	Do.
		do	18–20	En route to Washington, D. C.
			21–31	Washington, D. C.
	Feb. 1 to Mar. 31	do		Do.
	April	do	1– 2	Do.
			3–16	En route to Fort Pickens, Fla.
			17–30	Fort Pickens, Fla.
	May 1 to Aug. 31	do		Do.
	September	do	1–16	Do.
			17–30	En route to West Point, N. Y.
	October	do	1–29	West Point, N. Y.
			30–31	En route to Washington, D. C.
	Nov. 1 to Dec. 31	do		Washington, D. C.

NOTE.—Subsequent to Dec. 31, 1861, Company A, operating with 3 additional companies of miners, sappers and pontoniers, served as a provisional U. S. Engineer battalion. (See U. S. Engineer Battalion, following.)

U. S. ENGINEER BATTALION—SAPPERS, MINERS, AND PONTONIERS, CONSISTING OF COMPANIES A, B, C, D, AND E

Companies B, C, and D authorized as Sappers, Miners, and Pontoniers and Company E originally authorized as a company of Topographical Engineers under General Order No. 54, Aug. 10, 1861.

Year	Month	Element	Dates	Station
1861	December	Company A	1-31	Washington, D. C.
		Companies B and C	-31	Do.

NOTE.—(1) Capt. Thomas Lincoln Casey was detailed to recruit Company B at Portland, Maine, per Special Orders No. 216, War Department, Adjutant General's Office, dated Aug. 12, 1861, and Engineer Department letter Aug. 13, 1861. The first man was enlisted and assigned Sept. 5, 1861, and the Company was first mustered at Portland, Maine, on Oct. 31, 1861. By par. 14, S. O. No. 312, Headquarters of the Army, Adjutant General's Office, dated Nov. 23, 1861, 1st Lt. C. B. Reese, stationed at Cincinnati, Ohio, and the recruits enlisted in Company B at Portland, Maine, were directed to repair to the city of Washington and report to Captain Duane for duty with the Army of the Potomac. The company was mustered at Washington, D. C., on Dec. 31, 1861.

(2) Capt. J. B. McPherson was detailed to recruit Company C at Boston, Mass. The first man was enlisted and assigned Aug. 6, 1861, and the company was first mustered at Boston, Mass., on Oct. 31, 1861. By par. 14, S. O. No. 312, Headquarters of the Army, Adjutant General's Office, dated Nov. 23, 1861, 1st Lt. G. Weitzel, stationed in the Department of Florida, and the recruits enlisted in Company C, at Boston, Mass., were directed to repair to the city of Washington and report to Captain Duane for duty with the Army of the Potomac. The company was mustered at Washington, D. C., on Dec. 31, 1861.

1862	January	U. S. Engineer Battalion (Companies A, B, and C).	1-31	Washington, D. C.
	February	do	1-23	Do.
			24	En route to Sandy Hook, Md.
			25-28	Sandy Hook, Md.
	March	do	1- 3	Do.
			4	En route to Washington, D. C.
			5-10	Washington, D. C.
			11	En route to Fairfax, Va.
			12-14	Fairfax, Va.
			15	En route to Washington, D. C.
			16-26	Washington, D. C.
			27-29	En route to Hampton, Va.
			30-31	Hampton, Va.
	April	do	1- 4	Do.
			5-30	On the march with the Army of the Potomac and employed on works before Yorktown, Va. At the end of the month stationed at Camp Winfield Scott, near Yorktown, Va.
	May	U. S. Engineer Battalion	1- 7	Camp Winfield Scott near Yorktown, Va.
			8-31	On the march with the Army of the Potomac constructing pontoon bridges. At the end of the month in camp near New Bridge, Va.
	June	do	1-18	In camp near New Bridge, Va.
			19	Crossed Chickahominy River and encamped at Camp Lincoln, Va.
			20-26	Camp Lincoln, Va.
			27	Changed station to Savage Station, Va., from this point moved with the Army of the Potomac, arriving at Turkey Bend near Haxall's Landing, Va., on June 30, 1862.
	July	do	1	Moved from camp at Turkey Bend near Haxall's Landing, Va., to camp near Harrison's Landing, Va.
			2-31	Intrenching operations and in camp near Harrison's Landing, Va.

NOTE.—Company D was organized per General Orders No. 4, dated Headquarters, U. S. Engineer Troops, camp near Harrison's Landing, Va., on July 5, 1862.

Year	Month	Element	Dates	Station
1862	August	U. S. Engineer Battalion (Companies A, B, C, and D).	1–10	In camp near Harrison's Landing, Va.
			11	Hampton, Va.
			12–18	Construction and dismantling of ponton bridge across the inside of the mouth of the Chickahominy River.
			19	Hampton, Va.
			20	En route to Aquia Creek, Va. (by boat).
			21	At anchor in Aquia Creek, Va.
			22–30	In camp near Aquia Creek, Va.
			31	Embarked on S. S. *Niagara* and anchored in Potomac River.
	September	do	1	En route to Alexandria, Va. (by boat).
			2	In camp near Alexandria, Va.
			3	En route to Washington, D. C.
			4–6	Encamped on Arsenal Grounds, Washington, D. C.
		U. S. Engineer Battalion	7–21	Took up the line of march of General McClellan's army from Washington, D. C., through Frederick, Middletown, and Boonsboro—at the Battle of Antietam—afternoon of 21st left camp near Sharpsburg and arrived at Sandy Hook, Md.
			22–30	Sandy Hook, Md.
	October	do	1–31	Do.
	November	do	1–2	Do.
			3–8	On the march en route to Warrenton, Va.
			9–16	Warrenton, Va.
			17–20	On the march en route to Falmouth, Va.
			21–30	In camp near Falmouth, Va.
  1863	December 1 to May 31	do		Do.

NOTE.—Upon consolidation of the Corps of Topographical Engineers and the Corps of Engineers, announced in General Orders No. 79, War Department, Adjutant General's Office, Mar. 31, 1863, Company E was assigned to the Battalion of Sappers, Miners, and Pontoniers, replacing the former Company A, Topographical Engineers. Capt. Thomas L. Casey was assigned to the command and organization of this company. Company E was not organized, however, by Captain Casey, and on Dec. 18, 1865, was organized at Jefferson Barracks, Mo.

Year	Month	Element	Dates	Station
	June	U. S. Engineer Battalion	1–13	In camp near Falmouth, Va.
			14	Aquia Creek, Va.
			15	En route to Occoquan Creek, Va.
			16–17	Occoquan Creek, Va.
			18	En route to Alexandria, Va.
			19	En route to Edwards Ferry, Md., via Georgetown Canal.
			20–30	On the march with the Army of the Potomac into Maryland and Pennsylvania.
	July	do	1–31	On the march with the Army of the Potomac through Pennsylvania and Maryland.
	August	do	1–31	Rappahannock Station, Va.
	September	do	1–22	Do.
			23	Marched to Culpepper, Va.
			24	Marched to Rappahannock Station, Va.
			25–26	Rappahannock Station, Va.
		do	27–30	Culpepper, Va.
	October	do	1–9	Do.
			10–12	Rappahannock Station, Va.
			13–15	En route to Centreville, Va.
			16–18	Centreville, Va.
			19	En route to Groveton, Va.
			20	En route to Warrenton, Va.
			21–26	Warrenton, Va.
			27	En route to Auburn, Va.
			28	Auburn, Va.
			29	En route to Catlett's Station, Va.
			30–31	Catlett's Station, Va.
	November	do	1–6	Do.
			7	En route to Kellys Ford, Va.
			8–13	Kellys Ford, Va.
			14	En route to Brandy Station, Va.
			15–25	Repairing roads from Culpepper to Rappahannock Station, Va.

Year	Month	Element	Dates	Station
1922	Oct. 1 to Nov. 30	Regiment less Company C		Schofield Barracks, T. H.
		Company C		Waimea Canyon, Island of Oahu.
1926	Dec. 1 to Mar. 31	Regiment		Schofield Barracks, T. H.
	April	Regiment less Company E	1-30	Do.
		Company E	1-21	Do.
			22-30	Camp at Kawaihapai, Military Reservation.
	May	Regiment less Companies A, C, D, E, F, and Band.	1-31	Schofield Barracks, T. H.
		Companies A, C, D, F, and Band.	1-27	Do.
			28-31	Fort Armstrong, T. H.
		Company E	1- 7	Camp at Kawaihapai Military Reservation.
			8-27	Schofield Barracks, T. H.
			28-31	Fort Armstrong, T. H.
	June	Regiment less Companies A, C, D, E, F, and Band.	1-30	Schofield Barracks, T. H.
		Companies A, C, D, E, F	1-30	Fort Armstrong, T. H.
		Band	1-15	Do.
			16-30	Schofield Barracks, T. H.
	July	Regiment less Companies A, C, D, E, F.	1-31	Do.
		Companies A and C	1-31	Fort Armstrong, T. H.
		Companies D, E, F	1-15	Do.
			16-31	Schofield Barracks, T. H.
	August	Regiment less Companies A and C.	1-31	Do.
		Companys A and C	1-14	Fort Armstrong, T. H.
			15-31	Schofield Barracks, T. H.
1927	Sept 1 to June 30	Regiment		Do.
	July	Regiment less Companies B, E, F, and Hq. & Serv. Company.	1- 4	Do.
			5-27	Rest Camp, Puena Point.
			28-31	Schofield Barracks, T. H.
		Companies B, E, F, and Hq. & Serv. Company.	1-31	Do.
	August	Regiment[10]	1-31	Do.
	Sept. 1 to Oct. 31	do.[11]		Do.
1928	Nov. 1 to Jan. 31	do.		Do.
	February	Regiment less Company C	1-29	Do.
		Company C	1-13	Do.
			14-29	Fort Kamehameha, T. H.
	March	Regiment less Company C	1-31	Schofield Barracks, T. H.
		Company C	1-31	Fort Kamehameha, T. H.
	April	Regiment less Company C	1-30	Schofield Barracks, T. H.
		Company C	1-16	Fort Kamehameha, T. H.
			17-30	Schofield Barracks, T. H.
1929	May 1 to May 31	Regiment		Do.
	June	Regiment less Companies A, B, C.	1-30	Do.
		Company A	1- 8	Do.
			9-22	Ewa Sector (maneuvers).
			23-30	Schofield Barracks, T. H.
		Company B	1- 8	Do.
			9-22	Haleiwa Sector (maneuvers).
			23-30	Schofield Barracks, T. H.
		Company C	1- 5	Do.
			6-22	Punchbowl, Honolulu, T. H.
			23-30	Schofield Barracks, T. H.
	July	Regiment less Companies D, E, F.	1-31	Do.
		Companies D, E, and F	1- 7	Do.
			8-30	Practice march to Fort Ruger and return.
			31	Schofield Barracks, T. H.
	August	Regiment less Companies A, B, C, and Hq. & Serv. Company.	1-31	Do.
		Companies A, B, C	1- 5	Do.
			6-17	En route to Puuiki, T. H. (marching).
			18-30	Puuiki, T. H.
			31	Schofield Barracks, T. H.

[10] Band was organized as separate element Aug. 1, 1927.

[11] 1st and 2d Battalion Headquarters were organized in accordance with T. O. 64 P on October 18, 1927.

Year	Month	Element	Dates	Station
1871	March	Battalion less Companies D and E.	1-31	Willetts Point, N. Y.
		Company D	1-10	Yerba Buena Island, Calif.
			11-21	En route to Willetts Point, N. Y.
			22-31	Willetts Point, N. Y.
		Company E	1- 3	En route to West Point, N. Y.
			4-31	West Point, N. Y.
	Apr. 1 to	Battalion less Company E		Willetts Point, N. Y.
1877	June 30	Company E		West Point, N. Y.
	July	Battalion less Companies D and E.	1-20	Willetts Point, N. Y.
			21-31	Philadelphia, Pa.
		Company D	1-31	Willetts Point, N. Y.
		Company E	1-31	West Point, N. Y.
	August	Battalion less Companies D and E.	1- 2	Philadelphia, Pa.
			3-17	Easton, Pa.
			18-31	Willetts Point, N. Y.
		Company D	1-31	Do.
		Company E	1-31	West Point, N. Y.
	Sept. 1 to	Battalion less Company E		Willetts Point, N. Y.
1898	Mar. 31	Company E		West Point.

NOTE.—Returns show no officers or men assigned to Company D from August 1879 to March 1898, inclusive, and the company is not shown as having any activities.

Year	Month	Element	Dates	Station
	April[1]	Battalion less Company E	1-30	Willetts Point, N. Y.
		Company E	1-29	West Point, N. Y.
			30	Sailed for Key West, Fla.
	May	Battalion less Companies A, C, and E.	1-31	Willetts Point, N. Y.
		Company A	1-14	Do.
			15-31	En route to and stationed at San Francisco, Calif.; awaiting sailing to Philippine Islands.
		Company C	1-13	Willetts Point, N. Y.
			14-15	En route to Port Tampa, Fla.
			16-31	Port Tampa, Fla.
		Company E	1- 7	En route to Port Tampa, Fla.
			8-31	Port Tampa, Fla.
	June	Battalion less Companies A, C, and E.	1-30	Willetts Point, N. Y.
		Company A	1-25	Camp Merritt, San Francisco, Calif.
			26-30	En route to Philippine Islands. (A detachment of Company A sailed for the Philippines on June 15, 1898.)
		Companies C and E	1-5	Port Tampa, Fla.
			6-13	Aboard S. S. *Alamo*, Port Tampa, Fla.
			14-20	En route to Santiago, Cuba.
			22	Disembarked men and materials 10 miles east of Santiago, Cuba.
			27	Disembarked Siboney, Cuba.
			28-30	Encamped at Siboney, Cuba.
	July	Battalion less Companies A, C, and E.	1-31	Willetts Point, N. Y.
		Company A	1-31	Aboard Government transport *Indiana* en route to Philippine Islands.
		Companies C and E	1-31	At various places in the vicinity of Santiago, Cuba, and at close of month encamped 3½ miles NW of that place.
	August	Battalion less Companies A, C, and E.	1-31	Willetts Point, N. Y.
		Company A	1	Disembarked at Cavite Arsenal, P. I.
			7- 8	Cavite Arsenal, P. I.
			9-12	Camp Dewey near Manila, P. I.
			13	Took part in engagement before the city of Manila.
			14-31	Manila, P. I.
		Companies C and E	1-22	In camp, vicinity of Santiago, Cuba.
			23-29	En route from Santiago Harbor, Cuba, to Camp Wikoff, L. I., N. Y.
	September	Battalion less Companies A, C, and E.	1-30	Willetts Point, N. Y.

---

[1] Personnel assigned to Company D this month.

Year	Month	Element	Dates	Station
1898	September	Company A	1–30	Manila, P. I.
		Companies C and E	1–4	Camp Wikoff, L. I., N. Y.
			5–30	Willetts Point, N. Y.
	Oct. 1 to Nov. 30	Battalion less Companies A and E.		Do.
		Company A		Manila, P. I.
		Company E		West Point, N. Y.
	December	Battalion less Companies A and E.	1–31	Willetts Point, N. Y.
		Company A	1–28	Manila, P. I.
			29–31	Malate, P. I.
		Company E	1–31	West Point, N. Y.
1899	January	Battalion less Companies A and E.	1–31	Willetts Point, N. Y.
		Company A	1–31	Malate, P. I.
		Company E	1–31	West Point, N. Y.
	February	Battalion less Companies A and E.	1–28	Willetts Point, N. Y.
		Company A	1–28	Manila, P. I.
		Company E	1–28	West Point, N. Y.
	March	Battalion less Companies A, C, and E.	1–31	Willetts Point, N. Y.
		Company A	1–31	Manila, P. I.
		Company C	1–14	Willetts Point, N. Y.
			15–16	En route to Camp Meade, Middletown, Pa.
			17–31	Camp Meade, Middletown, Pa.
		Company E	1–31	West Point, N. Y.
	Apr. 1 to June 30	Battalion less Companies A, C, and E.		Willetts Point, N. Y.
		Company A		Manila, P. I.
		Company C		Camp Meade, Middletown, Pa.
		Company E		West Point, N. Y.
	July	Battalion less Companies A, B, C, and E.	1–31	Willetts Point, N. Y.
		Company A	1–31	Manila, P. I.
		Company B	1–4	Willetts Point, N. Y.
			5–11	En route to Angel Island, Calif.
			12	Angel Island, Calif.
			13–20	En route to Honolulu, T. H.
			21–22	Honolulu, T. H.
			20–31	En route to Philippine Islands.
		Company C	1–21	Camp Meade, Middletown, Pa.
			22–23	En route to Willetts Point, N. Y.
			24–31	Willetts Point, N. Y.
		Company E	1–31	West Point, N. Y.
	August	Battalion less Companies A, B, and E.	1–31	Willetts Point, N. Y.
		Company A	1–31	Manila, P. I.
		Company B	1–10	En route to Manila, P. I.
			11–13	Manila, P. I.
			14–17	Malate, P. I.
			18–31	San Fernando, P. I.
		Company E	1–31	West Point, N. Y.
	September	Battalion less Companies A, B, and E.	1–30	Willetts Point, N. Y.
		Company A	1–30	Manila, P. I.
		Company B	1–30	San Fernando, P. I.
		Company E	1–30	West Point, N. Y.
	October	Battalion less Companies A, B, and E.	1–31	Willetts Point, N. Y.
		Company A	1–31	Manila, P. I.
		Company B	1–31	Santa Rosa, P. I.
		Company E	1–31	West Point, N. Y.
	November	Battalion less Companies A, B, and E.	1–30	Willetts Point, N. Y.
		Company A	1–30	Manila, P. I.
		Company B	1–30	Binclonan, P. I.
		Company E	1–30	West Point, N. Y.
	Dec. 1	Battalion less Companies A, B, and E.		Willetts Point, N. Y.
	to	Company A		Manila, P. I.
1900	Feb. 29	Company B		Malate, P. I.
		Company E		West Point, N. Y.
	March	Battalion less Companies A, B, and E.	1–31	Willetts Point, N. Y.
		Companies A and B	1–31	Malate, P. I.
		Company E	1–31	West Point, N. Y.
	Apr. 1 to June 30	Battalion less Companies A, B, and E.		Willetts Point, N. Y.
		Company A		Bayambang, P. I.
		Company B		Malate, P. I.
		Company E		West Point, N. Y.
	July	Battalion less Companies A, B, and E.	1–31	Willetts Point, N. Y.

Year	Month	Element	Dates	Station
1900	July	Company A	1-31	Bayambang, P. I.
		Company B	1-31	Manila, P. I.
		Company E	1-24	West Point, N. Y.
			25-29	En route to Presidio, Calif.
			30-31	Presidio, Calif.
	August	Battalion less Companies A, B, and E.	1-31	Willetts Point, N. Y.
		Company A	1-31	Bayambang, P. I.
		Company B	1-31	Manila, P. I.
		Company E	1-26	En route to Nagasaki, Japan.
			27-28	Nagasaki, Japan.
			29-31	En route to Manila, P. I.
	September	Battalion less Companies A, B, and E.	1-30	Willetts Point, N. Y.
		Company A	1-30	Bayambang, P. I.
		Company B	1-30	Manila, P. I.
		Company E	1- 3	En route to Manila, P. I.
			4- 5	Aboard ship, Manila, P. I.
			6-30	Caloocan, P. I.
	October	Battalion less Companies A, B, and E.	1-31	Willetts Point, N. Y.
		Company A	1- 9	Bayambang, P. I.
			10-31	Dagupan, P. I.
		Company B	1-31	Manila, P. I.
		Company E	1-31	Caloocan, P. I.
	Nov. 1	Battalion less Companies A, B, and E.		Willetts Point, N. Y.
	to	Company A		Dagupan, P. I.
1901	Feb. 28	Company B		Manila, P. I.
		Company E		Caloocan, P. I.
	March	Battalion less Companies A, B, and E.	1-13	Willetts Point, N. Y.
			14	2d Engineer Battalion, organized under GO #22, 1901, from Companies C and D.
		Company A	1-31	Dagupan, P. I.
		Company B	1-31	Manila, P. I.
		Company E	1-31	Caloocan, P. I.
	April	Company A	1-30	Dagupan, P. I.
		Company B	1-30	Manila, P. I.
		Company E	1-30	Caloocan, P. I.
	May	Company A [3]	1-31	Dagupan, P. I.
		Company B [3]	1-31	Convent Malate, Manila, P. I.
		Company E [4]	1-31	Caloocan, P. I.

---

[3] Designations changed to Companies A and B respectively—1st Battalion of Engineers, per General Order No. 22, War Department, 1901.

[4] Designation changed to Company C, 1st Battalion of Engineers, per General Order No. 22, War Department, 1901.

COMPANY A, TOPOGRAPHICAL ENGINEERS

(Later Company E, U. S. Engineer Battalion 1861–1901)

Under the provisions of section 2, of an Act of Congress (Public, No. 52) approved August 6, 1861, and announced in War Department General Orders No. 54, 1861, there was authorized to be added to the Corps of Topographical Engineers (then consisting entirely of officers) one company of soldiers organized in the same manner as the Company of Sappers, Miners, and Pontoniers authorized for organization and attachment to the Corps of Engineers, by the Act of Congress approved May 16, 1846.

Special Orders No. 237, Headquarters of the Army, Adjutant General's Office, dated September 3, 1861, directed First Lt. C. N. Turnbull and Second Lt. James H. Wilson, Topographical Engineers, to proceed under the direction of the Chief of the Topographical Corps, to recruit and organize the company of soldiers authorized to be attached to it. These officers were out on recruiting duty during the month following the issuance of the special orders referred to but no account is available as to the results of their activities.

Special Orders No. 314, Headquarters of the Army, Adjutant General's Office, dated November 26, 1861, transferred Pvt. James W. Flood from the General Service to the Company of Topographical Engineer Soldiers, and directed that he report to Lt. C. N. Turnbull, at Boston. No returns or muster rolls were rendered for this company, and the records show that Private Flood was assigned to Company B, Sappers, Miners, and Pontoniers from recruit depot in January 1862.

The Corps of Topographical Engineers, as a distinct branch of the Army, was abolished and merged into the Corps of Engineers under the provisions of an Act of Congress (Public, No. 57) approved March 3, 1863, and announced in Section VII, General Orders, No. 73, War Department, Adjutant General's Office, dated March 24, 1863. As a result of this consolidation, units forming the Corps of Engineers and the assignment of officers to the Battalion of Sappers, Miners, and Pontoniers was announced in General Orders No. 79, War Department, Adjutant General's Office, dated March 31, 1863. Capt. Thomas L. Casey was assigned to Company E (late Company A, Topographical Engineers). General Orders No. 79, 1863, also provided that Captain Casey would continue at Portland, Maine, and, in addition to his other duties, would, under the direction of the Chief Engineer, recruit for the Engineer Companies A, B, C, and D, (in the field—Army of the Potomac), after filling which to their full complement he would organize his own company.

The records of The Adjutant General's Office do not disclose that any returns or muster rolls were ever rendered for Company A, Topographical Engineers, leading to the conclusion that this company was never actually organized. For subsequent history of this company, see "Company E, U. S. Engineer Battalion of Sappers, Miners, and Pontoniers," 1861–1901.

FIRST BATTALION OF ENGINEERS

In compliance with the requirements of General Order No. 22, Headquarters of the Army, Adjutant General's Office, Washington, D. C., February 26, 1901, the 1st Battalion of Engineers was organized from Companies A, B, and E, Battalion of Engineers, by Maj. Clinton B. Sears, Corps of Engineers, who assumed command on May 16, 1901. On May 31 the designation of Company "E," Battalion of Engineers, was changed to Company "C," 1st Battalion of Engineers.

Year	Month	Element	Dates	Station
1901	June	Company A	1–30	Dagupan, P. I.
		Company B	1–30	Manila, P. I.
		Company C	1–30	Caloocan, P. I.
		Company D [5]	7–30	Manila, P. I.
	July	Noncommissioned staff	1–31	Do.
		Company A	1–17	Dagupan, P. I.
			18–19	En route to Manila, P. I.
			20–25	En route to Nagasaki, Japan.
			26	Nagasaki, Japan.
			27–30	En route to Yokohama.
		Company B	1–31	Manila, P. I.
		Company C	1–31	Caloocan, P. I.
		Company D	1–26	Manila, P. I.
			27–31	Dagupan, P. I.
	August	Noncommissioned staff	1–31	Manila, P. I.
		Company A	1– 2	Yokohama, Japan.
			3–18	En route to San Francisco, Calif.
			19–22	Presidio, Calif.
			23–29	En route to Fort Totten, Willetts Point, N. Y.
			30–31	Fort Totten, N. Y.
		Company B	1–31	Manila, P. I.
		Company C	1–31	Caloocan, P. I.
		Company D	1–31	Dagupan, P. I.
	September	Noncommissioned staff	1–30	Manila, P. I.
		Company A	1–30	Fort Totten, Willetts Point, N. Y.
		Company B	1–30	Manila, P. I.
		Company C	1–11	Caloocan, P. I.
			12–13	En route to Manila, P. I.
			14–30	Manila, P. I.
		Company D	1–27	Dagupan, P. I.
			28–30	Manila, P. I.
	October	Battalion less Company A	1–16	Do.
			17–24	En route to Singapore, Straits Settlements.
			25–26	Singapore, Straits Settlements.
			27–31	En route to United States via Suez Canal.
		Company A	1–31	Fort Totten, N. Y.
	November	Battalion less Company A	1–30	En route to United States via Suez Canal.
		Company A	1– 6	Fort Totten, N. Y.
			7– 9	En route to Fort Leavenworth, Kans.
			10–30	Fort Leavenworth, Kans.
	December	Battalion less Company A	1–23	En route to United States.
		Company A	1–31	Fort Leavenworth, Kans.
		Headquarters, Companies B and D.	24–25	En route to Jefferson Barracks, Mo.
			26–31	Jefferson Barracks, Mo.
		Company C	24–31	West Point, N. Y.
1902	January	Headquarters	1–18	Jefferson Barracks, Mo.
			19–31	Fort Leavenworth, Kans.
		Company A	1–31	Do.
		Companies B and D	1–31	Jefferson Barracks, Mo.
		Company C	1–31	West Point, N. Y.
	Feb. 1 to Mar. 31	Headquarters and Company A		Fort Leavenworth, Kans.
		Companies B and D		Jefferson Barracks, Mo.
		Company C		West Point, N. Y.

[5] Company D organized June 7, 1901, under provisions of General Order No. 22, Headquarters of the Army, Adjutant General's Office, February 26, 1901, by transfer of 1 sergeant, 4 corporals, and 6 first-class privates from Company A, 5 corporals and 7 first-class privates from Company B, and 4 corporals and 7 first-class privates from Company C.

Year	Month	Element	Dates	Station
1902	April	Headquarters and Company A	1-30	Fort Leavenworth, Kans.
		Companies B and D	1-10	Jefferson Barracks, Mo.
			11-30	Fort Leavenworth, Kans.
		Company C	1-27	West Point, N. Y.
			28-30	En route to Ft. Leavenworth, Kans.
	May 1 to Aug. 31	Battalion		Fort Leavenworth, Kans.
	September	do	1- 7	Do.
			8-19	Marching to Fort Riley, Kans.
			20-30	Fort Riley, Kans.
	October	do	1-10	Do.
			11-31	Fort Leavenworth, Kans.
1903	Nov. 1 to Mar. 31	do		Do.
	April	do	1-27	Do.
			28-30	St. Louis, Mo.
	May	do	1- 3	Do.
			4-31	Fort Leavenworth, Kans.
	June	Battalion less Companies A, B, and C.	1-30	Do.
		Companies A and C	1	Do.
			2- 9	Marching to Lawrence, Kans.
			10-30	Lawrence, Kans.
		Company B	1-12	Fort Leavenworth, Kans.
			13-30	Kansas City, Mo.
	July	Battalion less Companies A and C.	1-31	Fort Leavenworth, Kans.
		Companies A and C	1- 8	Lawrence, Kans.
			9-11	En route to Fort Leavenworth, Kans.
			12-31	Fort Leavenworth, Kans.
	August	Battalion	1-31	Do.
	September	do	1-22	Do.
			23-30	Marching to Fort Riley, Kans.
	October	do	1- 3	Do.
			4-31	Fort Riley, Kans.
	November	do	1- 2	Do.
			3-11	Marching to Fort Leavenworth, Kans.
			12-30	Fort Leavenworth, Kans.
1904	Dec. 1 to Aug. 31	do		Do.
	September	do	1-28	Do.
	October	do	1	En route to Lawrence, Kans.
			2- 9	Lawrence, Kans.
			10-12	En route to Fort Leavenworth, Kans.
		do	13-31	Fort Leavenworth, Kans.
1905	Nov. 1 to May 31	do		Do.
	June	Battalion less Companies A and B.	1-30	Do.
		Companies A and B	1-22	Do.
			23-26	En route to San Francisco, Calif.
			27-29	Presidio, San Francisco, Calif.
			30	En route to Manila, P. I. (U. S. A. T. *Logan*)
	July	Battalion less Companies A and B.	1-31	Fort Leavenworth, Kans.
		Company A	1-26	En route to Manila, P. I.
			27-31	Fort William McKinley, P. I.
		Company B	1-26	En route to Manila, P. I.
			27-30	En route to Camp Overton, Mindanao, P. I.
			31	Camp Overton, Mindanao, P. I.
	August	Battalion less Companies A and B.	1-31	Fort Leavenworth, Kans.
		Company A	1-10	Camp Overton, Mindanao, P. I.
			11-31	Pantar, Mindanao, P I
		Company B	1-31	Fort William McKinley, P. I.
	September	Battalion less Companies A and B.	1-24	Fort Leavenworth, Kans.
			25-28	En route to San Francisco, Calif.
			29-30	Presidio, San Francisco, Calif.
		Company A	1-30	Pantar, Mindanao, P. I.
		Company B	1-30	Fort William McKinley, P. I.
	October	Headquarters and Company D	1	Presidio of San Francisco, Calif.
			2-8	Fort McDowell, Calif.
			9-31	Fort Mason, Calif.
		Company A	1-31	Pantar, Mindanao, P. I.
		Company B	1-31	Fort William McKinley, P. I.

Year	Month	Element	Dates	Station
1905	October	Company C	1	Presidio, San Francisco, Calif.
			2	En route to Rodeo Valley, Calif.
			3-31	In camp at Rodeo Valley, Calif.
	Nov. 1 to Jan. 31	Headquarters and Company D		Fort Mason, Calif.
		Company A		Pantar, Mindanano, P. I.
1906		Company B		Fort William McKinley, P. I.
		Company C		In camp, Rodeo Valley, Calif.
	February	Headquarters and Company D	1-28	Fort Mason, Calif.
		Company A	1-28	Pantar, Mindanao, P. I.
		Company B	1-28	Fort William McKinley, P. I.
		Company C	1-11	In camp, Rodeo Valley, Calif.
			12	En route to Fort Mason, Calif.
			13-28	Fort Mason, Calif.
	Mar. 1 to Apr. 30	Battalion less Companies A and B.[6]		Do.
		Company A		Pantar, Mindanao, P. I.
		Company B		Fort William McKinley, P. I.
	May	Headquarters and Company D	1-31	Fort Mason, Calif.
		Company A	1-31	Pantar, Mindanao, P. I.
		Company B	1-31	Fort William McKinley, P. I.
		Company C	1-27	Fort Mason, Calif.
			28	Enroute to Rodeo Valley, Calif.
			29-31	In camp, Rodeo Valley, Calif.
	June	Headquarters	1-30	Fort Mason, Calif.
		Company A	1-30	Pantar, Mindanao, P. I.
		Company B	1-30	Fort William McKinley, P. I.
		Company C	1-14	In camp, Rodeo Valley, Calif.
			15	En route to Fort Mason, Calif.
			16-30	Fort Mason, Calif.
		Company D	1-14	Do.
			15	En route to Rodeo Valley, Calif.
			16-29	In camp, Rodeo Valley, Calif.
			30	En route to Fort Mason, Calif.
	July	Headquarters and Company D	1- 5	Fort Mason, Calif.
			6- 9	En route to American Lake, Wash.
			10-31	Camp Tacoma, American Lake, Wash.
		Company A	1-31	Pantar, Mindanao, P. I.
		Company B	1-31	Fort William McKinley, P. I.
		Company C	1- 5	Fort Mason, Calif.
			6-20	En route to American Lake, Wash.
			21-31	Camp Tacoma, American Lake, Wash.
	August	Battalion less Companies A and B.	1-31	Do.
		Company A	1-31	Pantar, Mindanao, P. I.
		Company B	1-31	Fort William McKinley, P. I.
	September	Battalion less Companies A, B, and D.	1-19	Camp Tacoma, American Lake, Wash.
			20-23	En route to Fort Mason, Calif.
			24-30	Fort Mason, Calif.
		Company A	1-30	Pantar, Mindanao, P. I.
		Company B	1-30	Fort William McKinley, P. I.
		Company D	1-19	Camp Tacoma, American Lake, Wash.
			20-23	En route to Fort Mason, Calif.
			24	Fort Mason, Calif.
			25	En route to Rodeo Valley, Calif.
			26-30	In camp, Rodeo Valley, Calif.
	October	Battalion less Companies A, B, and D.	1-31	Fort Mason, Calif.
		Company A	1-31	Pantar, Mindanao, P. I.
		Company B	1-31	Fort William McKinley, P. I.
		Company D	1- 4	In camp, Rodeo Valley, Calif.
			5	En route to Fort Mason, Calif.
			6-31	Fort Mason, Calif.
	Nov. 1 to Mar. 31	Battalion less Companies A and B.		Do.
		Company A		Pantar, Mindanao, P. I.
1907		Company B		Fort William McKinley, P. I.
	April	Headquarters	1-30	Fort Mason, Calif.
		Company A	1-30	Pantar, Mindanao, P. I.
		Company B	1-30	Fort William McKinley, P. I.
		Company C	1	En route to Rodeo Valley, Calif.
			2-29	In camp, Rodeo Valley, Calif.
			30	En route to Fort Mason, Calif.
		Company D	1-29	Fort Mason, Calif.
			30	En route to Rodeo Valley, Calif.
	May	Headquarters and Company C	1-31	Fort Mason, Calif.
		Company A	1-31	Pantar, Mindanao, P. I.
		Company B	1-31	Fort William McKinley, P. I.

[6] Battalion less Companies A and B assisted in caring for refugees of San Francisco earthquake during April.

Year	Month	Element	Dates	Station
1907	May	Company D	1-26	In camp, Rodeo Valley, Calif.
			27	En route to Fort Mason, Calif.
			28-31	Fort Mason, Calif.
	June	Battalion less Companies A and B.	1-30	Do.
		Company A	1-30	Pantar, Mindanao, P. I.
		Company B	1-30	Fort William McKinley, P. I.
	July	Headquarters	1-31	Fort Mason, Calif.
		Company A	1-31	Pantar, Mindanao, P. I.
		Company B	1- 3	Fort William McKinley, P. I.
			4	En route to Grande Island, Subig Bay, P. I.
			5-31	Grande Island, Subig Bay, P. I.
		Companies C and D	1- 4	Fort Mason, Calif.
			5-31	En route to Manila, P. I. (U. S. Army transport *Sherman*).
	August	Headquarters	1-31	Fort Mason, Calif.
		Company A	1- 8	Pantar, Mindanao, P. I.
			9	En route to Camp Overton, Mindanao, P. I.
			10-12	En route to Mariveles, P. I.
			13-14	Mariveles, P. I.
			15-31	En route to United States.
		Company B	1-13	Grande Island, Subig Bay, P. I.
			14	En route to Mariveles, P. I.
			15-31	En route to United States.
		Company C	1- 4	En route to Manila, P. I.
			5- 7	Aboard U. S. Army transport *Sherman*, Manila, P. I.
			8-10	En route to Pantar, Mindanao, P. I.
			11-31	Pantar, Mindanao, P. I.
		Company D	1- 4	En route to Manila, P. I.
			5-12	Fort William McKinley, P. I.
			13	En route to Grande Island, Subig Bay, P. I.
			14-31	Grande Island, Subig Bay, P. I.
	September	Headquarters	1-30	Fort Mason, Calif.
		Companies A and B	1-16	En route to United States.
			17-30	Fort Mason, Calif.
		Company C	1-30	Pantar, Mindanao, P. I.
		Company D	1-30	Grande Island, Subig Bay, P. I.
	October	Headquarters and Company A	1-31	Fort Mason, Calif.
		Company B	1-29	Do.
			30	En route to Fort Flagler, Wash.
		Company C	1-31	Pantar, Mindanao, P. I.
		Company D	1-26	Grande Island, Subig Bay, P. I.
			27	En route to Fort William McKinley.
			28-31	Fort William McKinley, P. I.
	November	Headquarters and Company A	1-30	Fort Mason, Calif.
		Company B	1- 2	En route to Fort Flagler, Wash.
			3-30	Fort Flagler, Wash.
		Company C	1-30	Pantar, Mindanao, P. I.
		Company D	1-30	Fort William McKinley, P. I.
	Dec. 1 to Apr. 30	Headquarters and Company A	--------	Fort Mason, Calif.
		Company B	--------	Fort Flagler, Wash.
1908		Company C	--------	Pantar, Mindanao, P. I.
		Company D	--------	Fort William McKinley, P. I.
	May	Headquarters	1-31	Fort Mason, Calif.
		Company A	1-17	Do.
			18-31	Point Bonita, Calif.
		Company B	1-31	Fort Flagler, Wash.
		Company C	1-31	Pantar, Mindanao, P. I.
		Company D	1-31	Fort William McKinley, P. I.
	June	Headquarters	1-30	Fort Mason, Calif.
		Company A	1-13	Point Bonita, Calif.
			14-30	Fort Mason, Calif.
		Company B	1-19	Vancouver Barracks, Wash.
			20-30	Murray, American Lake, Wash.
		Company C	1-30	Pantar, Mindanao. P. I.
		Company D	1-30	Fort William McKinley, P. I.
	July 1 to Aug. 31	Headquarters and Company A	--------	Fort Mason, Calif.
		Company B	--------	American Lake, Wash.
		Company C	--------	Pantar, Mindanao, P. I.
		Company D	--------	Fort William McKinley, P. I.
	September	Headquarters	1-30	Fort Mason, Calif.
		Company A	1- 4	Do.
			5-23	En route to Atascadero, Calif.
			24-30	In camp, Atascadero, Calif.
		Company B	1-15	American Lake, Wash.
			16	En route to Vancouver Barracks, Wash.
			17-30	Vancouver Barracks, Wash.
		Company C	1-30	Pantar, Mindanao, P. I.
		Company D	1-30	Fort William McKinley, P. I.

Year	Month	Element	Dates	Station
1908	October	Headquarters	1-31	Fort Mason, Calif.
		Company A	1-29	In camp, Atascadero, Calif.
			30	En route to Fort Mason, Calif.
		Company B	1-31	Vancouver Barracks, Wash.
		Company C	1-31	Pantar, Mindanao, P. I.
		Company D	1-31	Fort William McKinley, P. I.
	November	Headquarters and Company A	1- 4	Fort Mason, Calif.
			5-12	En route to Honolulu, T. H.
			13-30	In camp, Waikiki Beach, T. H.
		Company B	1-30	Vancouver, Wash.
		Company C	1-30	Pantar, Mindanao, P. I.
		Company D	1- 2	En route to Fort Mills, Corregidor, P. I.
			3-30	Fort Mills, Corregidor, P. I.
	December	Headquarters and Company A	1-31	Waikiki Military Reservation, T. H.
		Company B	1-31	Vancouver Barracks, Wash.
		Company C	1-27	Pantar, Mindanao, P. I.
			28-31	Momungan, P. I.
		Company D	1-31	Fort Mills, P. I.
1909	Jan. 1 to Apr. 30	Headquarters and Company A		Waikiki Military Reservation, T. H.[7]
		Company B		Vancouver Barracks, Wash.
		Company C		Camp Momungan, Mindanao, P. I.
		Company D		Fort Mills, P. I.
	May	Headquarters and Company A	1- 5	Fort De Russy, T. H.
			6-13	En route to San Francisco, Calif.
			14	San Francisco, Calif.
			15-20	En route to Washington, D. C.
			21-31	Washington Barracks, D. C.
		Company B	1- 5	En route to Washington, D. C.
			6-31	Washington Barracks, D. C.
		Company C	1-24	Camp Momungan, Mindanao, P. I.
			25-26	En route to Fort Mills, Corregidor, P. I.
			27-31	Fort Mills, P. I.
		Company D	1-31	Do.
	June	Battalion less Companies C and D.	1-30	Washington Barracks, D. C.
		Companies C and D	1-30	Fort Mills, Corregidor, P. I.
	July	Battalion less Companies C and D.	1-31	Washington Barracks, D. C.
		Companies C and D	1-13	Fort Mills, Corregidor, P. I.
			14	En route to Mariveles, P. I.
			15-31	En route to United States.
	August	Battalion less Companies C and D	1-31	Washington Barracks, D. C.
		Companies C and D	1-10	En route to San Francisco, Calif.
			11	San Francisco, Calif.
		Companies C and D	12-17	En route to Washington, D. C.
			18-31	Washington Barracks, D. C.
	September	Battalion less Company A	1-30	Do.
		Company A	1-27	Do.
			28	En route to Camp Robert Shaw Oliver, Albany, N. Y.
			29-30	Camp Robert Shaw Oliver, Albany, N. Y.
	October	Battalion less Company A	1-31	Washington Barracks, D. C.
		Company A	1-11	Camp Robert Shaw Oliver, Albany, N. Y.
			12	En route to Washington, D. C.
			13-31	Washington Barracks, D. C.
1910	Nov. 1 to May 31	Battaltion		Do.
	June	Headquarters and Company B	1-30	Do.
		Companies A and D	1-23	Do.
			24-30	On the march to Gettysburg, Pa.
		Company C	1-15	Washington Barracks, D. C.
			16-17	En route to Nashville, Tenn.
			18-27	Camp Jacob M. Dickson, Nashville, Tenn.
			28-29	En route to Washington, D. C.
			30	Washington Barracks, D. C.
	July	Headquarters	1-31	Do.
		Companies A and D	1-30	Gettysburg, Pa.
			31	En route to Washington, D. C.
		Companies B and C	1-28	Washington, Barracks D. C.
			29-30	En route to Pine Camp, N. Y.
			31	Pine Camp, N. Y.
	August	Headquarters	1-31	Washington Barracks, D. C.
		Companies A and D	1- 6	En route to Washington, D. C.
			7-31	Washington Barracks, D. C.

[7] Changed to Fort De Russy in February.

Year	Month	Element	Dates	Station
1910	August	Companies B and C	1-29	Pine Camp, N. Y.
			30-31	En route to Sunbury, Pa.
	September	Headquarters and Companies A and D	1-30	Washington Barracks, D. C.
		Companies B and C	1-11	En route to Washington Barracks, D. C.
			12-30	Washington Barracks, D. C.
1912	Oct. 1 to June 30	Battalion		Do.
	July	Battalion less Company B	1-31	Do.
		Company B	1-11	Do.
			12	En route to Bridgeport, Conn.
			13-31	Huntington, Conn.
	August	Battalion less Company B	1-31	Washington Barracks, D. C.
		Company B	1-22	Huntington, Conn.
			23	En route to Washington, D. C.
			24-31	Washington Barracks, D. C.
1913	Sept. 1 to May 31	Battalion		Do.
	June	Battalion less Company C	1-30	Do.
		Company C	1-22	Do.
			23-30	Gettysburg, Pa.
	July	Battalion less Company C	1-31	Washington Barracks, D. C.
		Company C	1-21	Gettysburg, Pa.
			22-31	Mount Gretna, Pa.
	August	Battalion less Company C	1-31	Washington Barracks, D. C.
		Company C	1-21	Mount Gretna, Pa.
			22-31	Washington Barracks, D. C.
1915	Sept. 1 to Feb. 28	Battalion		Do.
	March	Battalion less Companies A and D.	1-31	Do.
		Company A	1-22	Do.
			23-31	Belvoir, Va.
		Company D	1-23	Washington Barracks, D. C.
			24-31	Belvoir, Va.
	Apr. 1 to May 31	Battalion less Companies A and D.		Washington Barracks, D. C.
		Companies A and D		Belvoir, Va.
	June	Battalion less Companies A, B, C, and D.	1-31	Washington Barracks, D. C.
		Company A	1- 4	Belvoir, Va.
			5-30	Washington Barracks, D. C.
		Company B	1- 7	Do.
			8-30	Belvoir, Va.
		Company C	1- 6	Washington Barracks, D. C.
			7-30	Belvoir, Va.
		Company D	1- 4	Do.
			5-30	Washington Barracks, D. C.
	July	Battalion less Companies B and C.	1-31	Do.
		Companies B and C	1-31	Belvoir Tract, Va.
	August	Headquarters	1-31	Washington Barracks, D. C.
		Company A	1-30	Do.
			31	On survey in New England States.
		Companies B and C	1-27	Belvoir Tract, Va.
			28-31	Washington Barracks, D. C.
		Company D	1- 4	Do.
			5-31	Plattsburg Barracks, N. Y.
	September	Battalion less Companies A and D.	1-30	Washington Barracks, D. C.
		Company A	1-30	Survey work in New England States.
		Company D	1-29	Plattsburg Barracks, N. Y.
			30	En route to Washington, D. C.
	October	Battalion less Company A	1-31	Washington Barracks, D. C.
		Company A	1-31	Survey work in New England States.
	November	Battalion less Companies A, C, and D.	1-30	Washington Barracks, D. C.
		Company A	1-26	Survey work in New England States.
			27-30	Washington Barracks, D. C.
		Company C	1- 8	Do.
			9-30	Fort Greble, R. I.
		Company D	1-30	Washington Barracks, D. C.
	December	Battalion less Company C	1-31	Do.
		Company C	1-14	Fort Greble, R. I.
			15-31	Washington Barracks, D. C.
1916	January	Battalion less Company B	1-31	Do.
		Company B	1-15	Do.
			16-31	Fort Screven, Ga.

Year	Month	Element	Dates	Station
1916	Feb. 1 to Mar. 31	Battalion less Company B		Washington Barracks, D. C.
		Company B		Fort Screven, Ga.
	April	Battalion less Companies B, C, and D.	1–30	Washington Barracks, D. C.
		Company B	1–30	Fort Screven, Ga.
		Company C	1–21	Washington Barracks, D. C.
			22–23	En route to Fort Oglethorpe, Ga.
			24–30	Fort Oglethorpe, Ga.
		Company D	1–23	Washington Barracks, D. C.
			24–30	Belvoir Tract, Va.
	May	Headquarters	1–31	Washington Barracks, D. C.
		Company A	1–21	Do.
			22–31	Belvoir Tract, Va.
		Company B	1–11	Fort Screven, Ga.
			12–31	Washington Barracks, D. C.
		Company C	1–11	Fort Oglethorpe, Ga.
			12–29	Target Range, Catoosa, Ga.
			30–31	Fort Oglethorpe, Ga.
		Company D	1–19	Belvoir Tract, Va.
			20–23	Washington Barracks, D. C.
			24–25	En route to Plattsburg Barracks, N. Y.
			26–31	Plattsburg Barracks, N. Y.
	June	Headquarters	1–19	Washington Barracks, D. C.
			20–24	En route to San Antonio, Tex.
			25–27	San Antonio, Tex.
			28	En route to Harlingen, Tex.
			29–30	Harlingen, Tex.
		Company A	1–12	Belvoir Tract, Va.
			13–19	Washington Barracks, D. C.
			20–24	En route to San Antonio, Tex.
			25–27	San Antonio, Tex.
			28	En route to Harlingen, Tex.
			29–30	Harlingen, Tex.
		Company B	1–11	Washington Barracks, D. C.
			12–13	Belvoir, Va.
			13–19	Washington Barracks, D. C.
			20–24	En route to Fort Sam Houston, Tex.
			25–30	Fort Sam Houston, Tex.
		Company C	1–13	Fort Oglethorpe, Ga.
			14–16	En route to Fort Sam Houston, Tex.
			17–30	Fort Sam Houston, Tex.
		Company D	1–30	Plattsburg Barracks, N. Y.

NOTE.—See First Regiment of Engineers.

SECOND BATTALION OF ENGINEERS

In compliance with General Order No. 22, Adjutant General's Office, February 26, 1901, the organization of the Second Battalion of Engineers, consisting of Companies E, F, G, and H, from former Companies C and D, United States Engineer Battalion, was effected March 14, 1901.

Year	Month	Element	Dates	Station
1901	Mar. 14 to May 31	Battalion		Fort Totten, N. Y.
	June	do	1-16	Do.
			17-20	En route to San Francisco, Calif.
			21-24	In camp, Presidio, Calif.
			25-30	En route to Philippine Islands aboard U. S. Army transport *Hancock*.
	July	do	1-16	En route to Philippine Islands.
			17	Aboard U. S. Army transport *Hancock*, Manila Bay, P. I.
			18-31	Manila, P. I.
	August	Battalion less Companies F and G.	1-31	Do.
		Company F	1-30	Do.
			31	En route to Iloilo, Panay, P. I.
		Company G	1-30	Manila, P. I.
			31	En route to Zamboanga, Mindanao, P. I.
	September	Battalion less Companies F and G.	1-30	Manila, P. I.
		Company F	1-30	Iloilo, Panay, P. I.
		Company G	1- 2	En route to Zamboanga, Mindanao, P. I.
			3-30	Zamboanga, Mindanao, P. I.
	October	Battalion less Companies F and G.	1-31	Manila, P. I.
		Company F	1-31	Iloilo, Panay, P. I.
		Company G	1-31	Zamboanga, Mindanao, P. I.
	November	Battalion less Companies F and G.	1-30	Manila, P. I.
		Company F	1-30	Iloilo, Panay, P. I.
		Company G	1-30	Post of Zamboanga, P. I.
	December	Battalion less Companies F and G.	1-31	Manila, P. I.
		Company F	1-31	Iloilo, Panay, P. I. (changed to Cebu, Cebu, Dec. 31, 1901).
		Company G	1-31	Post of Zamboanga, P. I.
1902	Jan. 1 to Apr. 30	Battalion less Companies F and G.		Manila, P. I.
		Company F		Cebu, Cebu, P. I.
		Company G		Post of Zamboanga, P. I.
	May	Battalion less Companies F and G.	1-31	Manila, P. I.
		Company F	1-17	Cebu, Cebu, P. I.
			18-21	En route to Malabang, Mindanao, P. I.
			22-31	Malabang, Mindanao, P. I.
		Company G	1-13	Zamboanga, P. I.
			14-16	En route to Malabang, Mindanao, P. I.
			17-31	Malabang, Mindanao, P. I.
	June	Battalion less Companies F and G.	1-30	Manila, P. I.
		Companies F and G	1-30	Malabang, Mindanao, P. I.
	July	Battalion less Companies F and G.	1-31	Manila, P. I.
		Company F	1-31	Mataling Falls, Mindanao, P. I.
		Company G	1-31	Camp X, Malabang, Mindanao, P. I.
	August	Battalion less Companies F and G.	1-31	Manila, P. I.
		Company F	1-31	Matataling Falls, Mindanao, P. I.
		Company G	1-16	Camp X, Malabang, Mindanao, P. I.
			17-31	Mataling, Falls, Mindanao, P. I.

Year	Month	Element	Dates	Station
1902	September	Battalion less Companies F and G.	1-30	Manila, P. I.
		Companies F and G	1-30	Mataling Falls, Mindanao, P. I.
	October	Battalion less Companies F and G.	1-31	Manila, P. I.
		Company F	1-31	Mataling Falls, Mindanao, P. I.
		Company G	1- 6	Do.
			7-17	En route to Iligan, Mindanao, P. I.
			18-31	Iligan, Mindanao, P. I.
	November	Battalion less Companies F and G.	1-30	Manila, P. I.
		Company F	1- 6	Mataling Falls, Mindanao, P. I.
			7-12	Campio, Mindanao, P. I.
			13-22	Malabang, Mindanao, P. I.
			23-25	En route to Iloilo, Panay, P. I.
			26-30	Iloilo, Panay, P. I.
		Company G	1-30	Iligan, Mindanao, P. I.
	December	Battalion less Companies F and G.	1-31	Manila, P. I.
		Company F	1-31	Iloilo, Panay, P. I.
		Company G	1-31	Iligan, Mindanao, P. I.
1903	January	Battalion less Companies F and G.	1-31	Manila, P. I.
		Company F	1-13	Iloilo, Panay, P. I.
			14-31	Camp Jossman, Guimaras, P. I.
		Company G	1-31	Iligan, Mindanao, P. I.
	Feb. 1 to Apr. 30	Battalion less Companies F and G.		Manila, P. I.
		Company F		Camp Jossman, Guimaras, P. I.
		Company G		Iligan, Mindanao, P. I.
	May	Battalion less Companies E, F, and G.	1-31	Manila, P. I.
		Company E	1- 6	Do.
			7-13	En route to Iligan, Mindanao, P. I.
			14-17	Iligan, Mindanao, P. I.
			18-31	Camp Pantar, Mindanao, P. I.
		Company F	1-31	Camp Jossman, Guimaras, P. I.
		Company G	1-10	Iligan, Mindanao, P. I.
			11-17	En route to Manila, P. I.
			18-31	Manila, P. I.
	June	Battalion less Companies E and F.	1- 5	Do.
			6- 8	Aboard U. S. Army transport *Thomas*.
			9-17	En route to Nagasaki, Japan.
			18-19	Nagasaki, Japan.
			20-30	En route to San Francisco, Calif.
		Company E	1-30	Camp Pantar, Mindanao, P. I.
		Company F	1-30	Camp Jossman, Guimaras, P. I.
	July	Battalion less Companies E and F.	1-10	En route to San Francisco, Calif.
			11-16	In camp, Presidio, San Francisco, Calif.
			17-22	En route to Washington, D. C.
			23-31	Washington Barracks, D. C.
		Company E	1-31	Camp Pantar, Mindanao, P. I.
		Company F	1-31	Camp Jossman, Guimaras, P. I.
	Aug. 1 to Sept. 30	Battalion less Companies E and F.		Washington Barracks, D. C.
		Company E		Camp Pantar, Mindanao, P. I.
		Company F		Camp Jossman, Guimaras, P. I.
	October	Battalion less Companies E and F.	1-31	Washington Barracks, D. C.
		Company E	1-11	Camp Pantar, Mindanao, P. I.
			12-18	En route to Manila, P. I.
			19-31	Manila, P. I.
		Company F	1-27	Camp Jossman, Guimaras, P. I.
			28-30	En route to Manila, P. I.
			31	Manila, P. I.
	November	Battalion less Companies E and F.	1-30	Washington Barracks, D. C.
		Companies E and F	1-10	Manila, P. I.
			11	En route to Mariveles, Luzon, P. I.
			12-13	Aboard U. S. Army transport *Sherman*.
			14-30	En route to United States.
	December	Battalion less Companies E and F.	1-31	Washington Barracks, D. C.
		Companies E and F	1-15	En route to San Francisco, Calif.
			16-17	Presidio, San Francisco, Calif.
			18-24	En route to Washington, D. C.
			25-31	Washington Barracks, D. C.
1904	Jan. 1 to Mar. 31	Battalion		Do.

Year	Month	Element	Dates	Station
1904	April	Battalion less Companies F and G.	1-30	Washington Barracks, D. C.
		Companies F and G	1-21	Do.
			22-30	En route to Mount Gretna, Pa.
	May	Battalion less Companies F and G.	1-31	Washington Barracks, D. C.
		Companies F and G	1-22	Mount Gretna, Pa.
			23-31	En route to Washington, D. C.
	June	Battalion less Companies E and H.	1-30	Washington Barracks, D. C.
		Companies E and H	1- 2	Do.
			3-30	Enroute to and at Mount Gretna, Pa.
	July	Battalion less Companies E and H.	1-31	Washington Barracks, D. C.
		Companies E and H	1-12	Mount Gretna, Pa., and en route to Washington, D. C.
			13-31	Washington Barracks, D. C.
	August	Battalion less Company G	1-15	Do.
			16-31	Army maneuvers (Virginia).
		Company G	1-31	Washington Barracks, D. C.
	September	Battalion less Company G	1-16	Army maneuvers (Virginia).
			17-30	Washington Barracks, D. C.
		Company G	1-30	Do.
1905	Oct. 1 to Apr. 30	Battalion		Do.
	May	Battalion less Companies F and G.	1-31	Do.
		Companies F and G	1-28	Do.
			29-31	Saunders Range, Md.
	June	Headquarters	1-30	Washington Barracks, D. C.
		Companies E and H	1-25	Do.
			26-30	Saunders Range, Md.
		Companies F and G	1-22	Do.
			23-30	Washington Barracks, D. C.
	July	Battalion less Companies E and H.	1-31	Do.
		Companies E and H	1-22	Saunders Range, Md.
			23-31	Washington Barracks, D. C.
1906	Aug. 1 to Apr. 30	Battalion		Do.
	May	Battalion less Companies E and H.	1-31	Do.
		Companies E and H	1-21	Do.
			22-31	Annapolis, Md.
	June	Battalion less Companies E and H.	1-30	Washington Barracks, D. C.
		Companies E and H	1-14	Annapolis, Md.
			15-30	Washington Barracks, D. C.
	July	Battalion less Companies F and G.	1	Do.
			2	En route to Mount Gretna, Pa.
			3-31	Mount Gretna, Pa.
		Companies F and G	1	Washington, D. C.
			2- 3	En route to Chickamauga, Ga.
			4-31	Chickamauga, Ga.
	August	Battalion less Companies F and G.	1-31	Mount Gretna, Pa.
		Companies F and G	1-31	Chickamauga, Ga.
	September	Battalion less Companies F and G.	1-16	Mount Gretna, Pa.
			17	En route to Washington Barracks, D. C.
			18-30	Washington Barracks, D. C.
		Companies F and G	1- 4	Chickamauga, Ga.
			5-27	Catoosa Springs, Ga.
			28-29	En route to Washington Barracks, D. C.
			30	Washington Barracks, D. C.
	October	Battalion	1	En route to Brooklyn, N. Y.
			2- 6	En route to Habana, Cuba (U. S. Army transport *Sumner*).
			7	En route to Camp Columbia, Habana, Cuba.
			8-31	Camp Columbia, Habana, Cuba
1907	Nov. 1 to May 31	Battalion		Do.
	June	Battalion less Companies E and H.	1-30	Do..
		Companies E and H	1-24	Do.
			25-30	U. S. Army transport *Kilpatrick* en route to United States.

Year	Month	Element	Dates	Station
1907	July	Battalion less Companies E and H.	1-31	Camp Columbia, Habana, Cuba.
		Companies E and H	1	En route via Newport News, Va., to Washington Barracks, D. C.
			2-31	Washington Barracks, D. C.
	Aug. 1 to Oct. 31	Battalion less Companies E and H.		Camp Columbia, Habana, Cuba.
		Companies E and H		Washington Barracks, D. C.
	November	Battalion less Companies E and H.	1-24	Camp Columbia, Habana, Cuba.
			25-26	En route to target range near Guanajay, Pinar del Rio, Cuba.
			27-30	Target range near Guanajay, Pinar del Rio, Cuba.
		Companies E and H	1-30	Washington Barracks, D. C.
	December	Battalion less Companies E and H.	1-21	Target range near Guanajay, Pinar del Rio, Cuba.
			22	En route to Camp Columbia, Habana, Cuba.
			23-31	Camp Columbia, Habana, Cuba.
		Companies E and H	1-31	Washington Barracks, D. C.
1908	January	Battalion less Companies E, F, and H.	1-31	Camp Columbia, Habana, Cuba.
		Company F	1-21	Do.
			22-31	En route to Guines, Habana Province, Cuba.
		Companies E and H	1-31	Washington Barracks, D. C.
	February	Battalion less companies E and H.	1- 7	Camp Columbia, Habana, Cuba.
			8- 9	En route to Guanajay, Pinar del Rio, Cuba.
			10-29	Camp near Guanajay, Pinar del Rio, Cuba.
		Companies E and H	1-29	Washington Barracks, D. C.
	March	Battalion less Companies E and H.	1- 8	Target range near Guanajay, Pinar del Rio, Cuba.
			9-10	En route to Camp Columbia, Habana, Cuba.
			11-31	Camp Columbia, Habana, Cuba.
		Companies E and H	1-31	Washington Barracks, D. C.
	April	Battalion less Companies E and H.	1-30	Camp Columbia, Habana. Cuba.
		Companies E and H	1-30	Washington Barracks, D. C.
	May	Battalion less Companies E and H.	1-31	Camp Columbia, Habana, Cuba.
		Companies E and H	1-18	Washington, Barracks, D. C.
			19-20	En route to Pine Plains, N. Y.
			21-31	Pine Camp, N. Y.
	June	Battalion less Companies E and H.	1-30	Camp Columbia, Habana, Cuba.
		Companies E and H	1-30	Pine Camp, N. Y.
	July	Battalion less Companies E and H.	1-31	Camp Columbia, Habana, Cuba.
		Companies E and H	1-14	Pine Camp, N. Y.
			15-27	Marching to Fort Niagara, N. Y.
			28-31	Fort Niagara, N. Y.
	August	Battalion less Companies E and H.	1-31	Camp Columbia, Habana, Cuba.
		Companies E and H	1-24	Fort Niagara, N. Y.
			25-26	En route to Washington, D. C.
			27-31	Washington Barracks, D. C.
	September	Battalion less Companies E and H.	1-30	Camp Columbia, Habana, Cuba.
		Companies E and H	1-30	Washington Barracks, D. C.
	October	Battalion less Companies E and H.	1	Camp Columbia, Habana, Cuba.
			2- 7	Marching to San Cristobal, Cuba.
			8-16	Camped near San Cristobal, Cuba.
			17-22	Marched to Camp Columbia, Habana, Cuba.
			23-31	Camp Columbia, Habana, Cuba.
		Companies E and H	1-31	Washington Barracks, D. C.
	November	Battalion less Companies E and H.	1-17	Camp Columbia, Habana, Cuba.
			18-20	Practice march.
			21-30	Camp Columbia, Habana, Cuba.
		Companies E and H	1-30	Washington Barracks, D. C.
	December	Battalion less Companies E and H.	1- 9	Camp Columbia, Habana, Cuba.
			10-12	Practice march.
			13-31	Camp Columbia, Habana, Cuba.
		Companies E and H	1-31	Washington Barracks, D. C.
1909	January	Battalion less Companies E and H.	1- 5	Camp Columbia, Habana, Cuba.
			6- 8	Practice march.
			9-31	Camp Columbia, Habana, Cuba
		Companies E and H	1-31	Washington Barracks, D. C.

Year	Month	Element	Dates	Station
1909	Feb. 1 to Mar. 31	Battalion less Companies E and H.		Camp Columbia, Habana, Cuba.
		Companies E and H		Washington Barracks, D. C

NOTE.—At 12 M., Mar. 31, 1909, participated in the ceremony of lowering the flag of the United States and hoisting the flag of the Republic of Cuba at Camp Columbia, Cuba, and then proceeded to Habana and embarked on the transports *Sumner* and *McClellan* for the United States.

	April	Battalion less Companies E and H.	1- 4	En route to Newport News, Va. (transports *Sumner* and *McClellan*).
			5- 6	En route to Washington, D. C. (steamer *Norfolk*).
		Headquarters and Company G	7-27	Washington Barracks, D. C.
			28-30	En route to San Francisco, Calif.
		Companies E and H	1-30	Washington, Barracks D. C.
		Company F	7-24	Do.
			25-30	En route to Vancouver Barracks, Wash.
	May	Headquarters and Company G	1- 4	En route to San Francisco, Calif.
			5-13	En route to Honolulu (U. S. Army Transport *Sheridan*).
			14-31	Fort De Russy, T. H.
		Companies E and H	1-27	Washington Barracks, D. C.
			28-31	En route to San Francisco, Calif.
		Company F	1-31	Vancouver Barracks, Wash.
	June	Headquarters and Company G	1-30	Fort De Russy, Honolulu, T. H.
		Companies E and H	1- 3	En route to San Francisco, Calif.
			4	Aboard transport *Logan*.
			5-30	En route to Manila, P. I.
		Company F	1-30	Vancouver Barracks, Wash.
	July	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Companies E and H	1	En route to Manila, P. I.
			2	En route from Manila, P. I., to Fort Mills, P. I.
			3-31	Fort Mills, Corregidor, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
	Aug. 1 to Nov. 30	Headquarters and Company G		Fort De Russy, Honolulu, T. H.
		Companies E and H		Fort Mills, P. I.
		Company F		Vancouver Barracks, Wash.
	December	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-30	Fort Mills, P. I.
			31	Fort Santiago, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
		Company H	1-31	Fort Mills, P. I.
1910	January	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-31	Fort Santiago, Manila, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
		Company H	1-29	Fort Mills, Corregidor, P. I.
			30-31	Camp Otis, Manila, P. I.
	February	Headquarters and Company G	1-28	Fort De Russy, Honolulu, T. H.
		Company E	1-15	Fort Santiago, Manila, P. I.
			16-25	Maneuvers—marched to Orani, Bataan, P. I.
			26-28	Orani, Bataan, P. I.
		Company F	1-28	Vancouver Barracks, Wash.
		Company H	1-16	Camp Otis, Manila, P. I.
			17-27	Maneuvers.
			28	Camp Otis, Manila, P. I.
	March	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1	Orani, Bataan, P. I.
			2	En route to Manila, P. I.
			3- 8	Camp Otis, Manila, P. I.
			9-31	Fort Santiago, Manila, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.
	April	Headquarters and Company G	1-30	Fort De Russy, Honolulu, T. H.
		Company E	1-30	Fort Santiago, Manila, P. I.
		Company F	1-30	Vancouver Barracks, Wash.
		Company H	1-30	Fort Mills, Corregidor, P. I.
	May	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-31	Fort Santiago, Manila, P. I.
		Company F	1-31	Target Range, Proebstel, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.
	June	Headquarters and Company G	1-30	Fort De Russy, Honolulu, T. H.
		Company E	1-27	Fort Santiago, Manila, P. I.
			28-30	Camp Ward Cheney, Cavite, P. I.
		Company F	1-19	Vancouver Barracks, Wash.
			20-30	American Lake, Cosgrove, Wash.
		Company H	1-30	Fort Mills, Corregidor, P. I.
	July	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-31	Camp Ward Cheney, Cavite, P. I.
		Company F	1-31	Cosgrove, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.

Year	Month	Element	Dates	Station
1910	August	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-31	Camp Ward Cheney, Cavite, P. I.
		Company F	1-25	American Lake, Wash.
			26-31	Vancouver Barracks, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.
	Sept. 1 to Nov. 30	Headquarters and Company G		Fort De Russy, Honolulu, T. H.
		Company E		Camp Ward Cheny, Cavite, P. I.
		Company F		Vancouver Barracks, Wash.
		Company H		Fort Mills, Corregidor, P. I.
	December	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1- 4	Camp Ward Cheney, Cavite, P. I.
			5-31	Fort Santiago, Manila, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.
1911	Jan. 1 to Mar. 31	Headquarters and Company G		Fort De Russy, Honolulu, T. H.
		Company E		Fort Santiago, Manila, P. I.
		Company F		Vancouver Barracks, Wash.
		Company H		Fort Mills, Corregidor, P. I.
	April	Headquarters and Company G	1-30	Fort De Russy, Honolulu, T. H.
		Company E	1-30	Fort Santiago, Manila, P. I.
		Company F	1-17	Vancouver Barracks, Wash.
			18-30	Target Range near Proebstel, Wash.
		Company H	1-30	Fort Mills, Corregidor, P. I.
	May	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-31	Fort Santiago, Manila, P. I.
		Company F	1-29	Target range near Proebstel, Wash.
			30-31	Vancouver Barracks, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.
	June	Headquarters and Company G	1-30	Fort De Russy, Honolulu, T. H.
		Company E	1-27	Fort Santiago, Manila, P. I.
			28-30	Camp Ward Cheney, Cavite, P. I.
		Company F	1-30	Vancouver Barracks, Wash.
		Company H	1-30	Fort Mills, Corregidor, P. I.
	July 1 to Nov. 30	Headquarters and Company G		Fort De Russy, Honolulu, T. H.
		Company E		Camp Ward Cheney, Cavite, P. I.
		Company F		Vancouver Barracks, Wash.
		Company H		Fort Mills, Corregidor, P. I.
	December	Headquarters and Company G	1-31	Fort De Russy, Honolulu, T. H.
		Company E	1-15	Camp Ward Cheney, Cavite, P. I.
			16-31	Fort Santiago, Manila, P. I.
		Company F	1-31	Vancouver Barracks, Wash.
		Company H	1-31	Fort Mills, Corregidor, P. I.
1912	Jan. 1 to Feb. 29	Headquarters and Company G		Fort De Russy, Honolulu, T. H.
		Company E		Fort Santiago, Manila, P. I.
		Company F		Vancouver Barracks, Wash.
		Company H		Fort Mills, Corregidor, P. I.
	March	Headquarters and Company G	1-31	Fort De Russy, Honoluly, T. H.
			1-14	Fort Santiago, Manila, P. I.
			15-31	En route to United States.
		Company F	1-31	Vancouver Barracks, Wash.
		Company H	1-14	Fort Mills, Corregidor, P. I.
			15-31	En route to United States.
	April	Battalion Headquarters and Company G.	1- 4	Fort De Russy, Honolulu, T. H.
			5-14	En route to San Francisco, Calif.
			15-19	En route to Fort Leavenworth, Kans.
			20-30	Fort Leavenworth, Kans.
		Companies E and H	1-14	En route to San Francisco, Calif.
			15-19	En route to Fort Leavenworth, Kans.
			2-30	Fort Leavenworth, Kans.
		Company F	1-30	Vancouver Barracks, Wash.
	May 1 to June 30	Battalion less Company F		Fort Leavenworth, Kans.
		Company F		Vancouver Barracks, Wash.
	July	Battalion less Company F	1-31	Fort Leavenworth, Kans.
		Company F	1-19	Vancouver Barracks, Wash.
			20-31	Maneuver Camp, Department of Columbia.
	August	Battalion less Company F	1-14	Fort Leavenworth, Kans.
			15-27	Maneuvers.
			28-31	Fort Leavenworth, Kans.
		Company F	1- 5	Marched to Vancouver Barracks, Wash.
			6-31	Vancouver Barracks, Wash.
	Sept. 1 to	Battalion less Company F		Fort Leavenworth, Kans.
1913	Jan. 31	Company F		Vancouver Barracks, Wash.
	February	Battalion less Companies E and F.	1-24	Fort Leavenworth, Kans.
			25-28	En route to Texas City, Tex.
		Company E	1-22	Fort Leavenworth, Kans.
			23-25	En route to Galveston, Tex.
			26-28	Fort Crockett Military Reservation, Galveston, Tex.
		Company F	1-28	Vancouver Barracks, Wash.

Year	Month	Element	Dates	Station
1913	Mar. 1 to Mar. 31	Battalion less Companies E and F		Texas City, Tex.
		Company E		Galveston, Tex.
1914		Company F		Vancouver Barracks, Wash.
	April	Battalion less Companies E and F.	1–15	Texas City, Tex.
			16–21	Practice march.
			22–30	Texas City, Tex.
		Company E	1–14	Fort Crockett, Tex.
			15–20	Practice march.
			21–23	Fort Crockett, Tex.
			24–28	En route to Vera Cruz, Mexico (U. S. Army transport *Meade*).
			29–30	Vera Cruz, Mexico.
		Company F	1–19	Vancouver Barracks, Wash.
			20–22	En route to Gilroy, Calif.
			23–30	Gilroy, Calif.
	May 1 to June 30	Battalion less Companies E and F.		Texas City, Tex.
		Company E		Vera Cruz, Mexico.
		Company F		Gilroy, Calif.
	July	Battalion less Companies E and F.	1–20	Texas City, Tex.
			21–31	Fort Crockett, Tex.
		Company E	1–31	Vera Cruz, Mexico.
		Company F	1– 6	Gilroy, Calif.
			7–31	Pacific Grove, Calif.
	August	Battalion less Companies E and F.	1–20	Fort Crockett, Tex.
			21–31	Texas City, Tex.
		Company E	1–31	Vera Cruz, Mexico.
		Company F	1– 2	Pacific Grove, Calif.
			3–21	Presidio of Monterey, Calif.
			22–24	En route to Vancouver Barracks, Wash.
			25–31	Vancouver Barracks, Wash.
	September	Battalion less Companies E and F.	1–30	Texas City, Tex.
		Company E	1–30	Vera Cruz, Mexico.
		Company F	1–30	Vancouver Barracks, Wash.
	October	Battalion less Companies E and F.	1– 7	Texas City, Tex.
			8–11	En route to Eatman's Ferry, Tex.
			12–31	Eatman's Ferry, Tex.
		Company E	1–31	Vera Cruz, Mexico.
		Company F	1–31	Vancouver Barracks, Wash.
	November	Battalion less Companies E and F.	1– 8	Eatman's Ferry, Tex.
			9–11	En route to Texas City, Tex.
			12–30	Texas City, Tex.
		Company E	1–22	Vera Cruz, Mexico.
			23–26	En route to Galveston, Tex.
		Company E	27–29	Galveston, Tex.
			30	Fort Crockett, Tex.
		Company F	1–30	Vancouver Barracks, Wash.
	Dec. 1 to Feb. 28	Battalion less Companies E and F.		Texas City, Tex.
		Company F		Fort Crockett, Tex.
1915		Company F		Vancouver Barracks, Wash.
	March	Battalion less Companies E and F.	1–31	Texas City, Tex.
		Company E	1–31	Fort Crockett, Tex.
		Company F	1–14	Vancouver Barracks, Wash.
			15–17	En route to Presidio of San Francisco, Calif.
			18–31	Presidio of San Francisco, Calif.
	Apr. 1 to May 31	Battalion less Companies E and F.		Texas City, Tex.
		Company E		Fort Crockett, Tex.
		Company F		Presidio of San Francisco, Calif.
	June	Battalion less Companies E and F.	1–30	Texas City, Tex.
		Company E	1–30	Fort Crockett, Tex.
		Company F	1– 3	Presidio of San Francisco, Calif.
			4–30	Santa Rosa, Calif.
	July 1 to Aug. 31	Battalion less Companies E and F.		Texas City, Tex.
		Company E		Fort Crockett, Tex.
		Company F		Santa Rosa, Calif.
	September	Battalion less Companies E and F.	1–30	Texas City, Tex.
		Company E	1–30	Fort Crockett, Tex.
		Company F	1–14	Santa Rosa, Calif.
			15–17	En route to Vancouver Barracks, Wash.
			18–30	Vancouver Barracks, Wash.
	October	Headquarters and Company H	1–31	Texas City, Tex.
		Company E	1–31	Fort Crockett, Tex.
		Company F	1–18	Oregon State Rifle Range.
			19–31	Vancouver Barracks, Wash.

Year	Month	Element	Dates	Station
1915	October	Company G	1- 6	Texas City, Tex.
			7-31	Dallas, Tex.
	November	Battalion less Companies E and F.	1- 2	Texas City, Tex.
			3- 4	En route to Fort Sam Houston, Tex.
			5-30	Fort Sam Houston, Tex.
		Company E	1- 2	Galveston, Tex.
			3- 4	En route to Fort Sam Houston, Tex.
			5-30	Fort Sam Houston, Tex.
		Company F	1-30	Vancouver Barracks, Wash.
	Dec. 1 to Feb. 29	Battalion less Company F		Fort Sam Houston, Tex.
1916		Company F		Vancouver Barracks, Wash.
	March	Headquarters and Company H	1-11	Fort Sam Houston, Tex.
			12-14	En route to Columbus, N. Mex.
			15	Columbus, N. Mex.
			16	Marched to Gibson's ranch, New Mexico.
		Headquarters and Company H	17	Crossed border into Mexico.
			18-31	With punitive expedition in Mexico.
		Company E	1-11	Fort Sam Houston, Tex.
			12-14	En route to Columbus, N. Mex.
			15-17	Columbus, N. Mex.
			18	Crossed border into Mexico.
			19-31	With punitive expedition in Mexico.
		Company F	1-31	Vancouver Barracks, Wash.
		Company G	1-11	Fort Sam Houston, Tex.
			12-25	En route to Columbus, N. Mex.
			26	Marched to Gibson's ranch, New Mexico.
			27	Crossed border into Mexico.
			28-31	With punitive expedition in Mexico.
	Apr. 1 to June 30	Battalion less Company F		Do.
		Company F		Vancouver Barracks, Wash.
	July	Battalion less Company F	1-31	With punitive expedition in Mexico.
		Company F		(See Company F, 2d Regiment of Engineers.)

NOTE.—See 2d Regiment of Engineers.

THIRD BATTALION OF ENGINEERS

In compliance with G. O. No. 22, Adjutant General's Office, February 26, 1901, the organization of the Third Battalion of Engineers was effected March 25, 1901, by transfers from Companies E and F, Second Battalion of Engineers.

Year	Month	Element	Dates	Station
1901	March	Battalion less Company M (Headquarters Companies I, K, L).	26–31	Fort Totten, N. Y.
		Company M	26–31	West Point, N. Y.
	Apr. 1 to Sept. 30	Battalion less Company M		Fort Totten, N. Y.
		Company M		West Point, N. Y.
	October	Battalion less Company M	1– 6	Fort Totten, N. Y.
			7– 9	Enroute to Washington Barracks, D. C.
			10–31	Washington Barracks, D. C.
		Company M	1–31	West Point, N. Y.
	November	Battalion less Company M	1–30	Washington Barracks, D. C.
		Company M	1–30	West Point, N. Y.
	December	Battalion less Company M	1–31	Washington Barracks, D. C.
		Company M	1–23	West Point, N. Y.
			24	En route to Washington, D. C.
			25–31	Washington Barracks, D. C.
1902	Jan. 1 to July 31	Battalion		Do.
	August	Battalion less Companies K, L, and M.	1–31	Do.
		Companies K and L	1–22	Do.
			23–24	En route to Fort H. G. Wright, N. Y.
			25–31	Fort H. G. Wright, N. Y.
		Company M	1	Washington Barracks, D. C.
			2– 3	En route to Fort Terry, N. Y.
			4–31	Fort Terry, N. Y.
	September	Battalion less Companies K, L, and M.	1–30	Washington Barracks, D. C.
		Companies K and L	1– 8	Fort H. G. Wright, N. Y., and en route to Washington, D. C.
			9–30	Washington Barracks, D. C.
		Company M	1–12	Fort Terry, N. Y., and enroute to Washington Barracks, D. C.
			13–30	Washington Barracks, D. C.
1903	Oct 1 to Mar. 31	Battalion		Do.
	April	Battalion less Companies I and K	1–30	Do.
		Companies I and K	1–14	Do.
			15–21	En route to San Francisco, Calif.
			22–30	Presidio, San Francisco, Calif.
	May	Battalion less Companies I and K.	1–31	Washington Barracks, D. C.
		Companies I and K	1–27	En route to Manila, P. I.
			28–31	Manila, P. I.
	June	Battalion less Companies I and K.	1–30	Washington Barracks, D. C.
		Companies I and K	1–30	Manila, P. I.
	July	Battalion less Companies I, K, and L.	1–31	Washington Barracks, D. C.
		Companies I and K	1–31	Manila, P. I.
		Company L	1–13	Washington Barracks, D. C.
			14–31	En route to and at Fort Preble, Maine.
	August	Battalion less Companies I, K, and L.	1–31	Washington Barracks, D. C.
		Companies I and K	1–31	Manila, P. I.
		Company L	1–30	Fort Preble, Maine.
			31	En route to Washington, D. C.
	September	Battalion less Companies I and K.	1–14	Washington Barracks, D. C.
			15–21	En route to Presidio, San Francisco, Calif.
			22–30	Presidio, San Francisco, Calif.
		Companies I and K	1–30	Manila, P. I.

Year	Month	Element	Dates	**Station**
1903	October	Battalion less Companies I and K.	1–28	En route to **Manila, P. I.** (U. S. Army transport ***Sherman***.)
			29–31	Manila, P. I.
		Company I	1–16	Do.
			17–29	En route to **Camp Jossman**, Guimaras, P. I.
			30–31	Camp Jossman, **Guimaras, P. I.**
		Company K	1– 4	Manila, P. I.
			5–10	En route to **Camp Pantar, Mindanao**, P. I.
			11–31	Camp Pantar, **Mindanao, P. I.**
	November	Battalion less Companies I and K.	1–30	Manila, P. I.
		Company I	1–30	Camp Jossman, **Guimaras, P. I.**
		Company K	1–30	Camp Pantar, **Mindanao, P. I.**
	December	Battalion less Companies I and K.	1–31	Manila, P. I.
		Company I	1–31	Camp Jossman, **Guimaras, P. I.**
		Company K	1–18	Camp Pantar, **Mindanao, P. I.**
			19–31	Camp Marahui, **Mindanao, P. I.**
1904	January	Battalion less Companies I and K.	1–31	Manila, P. I.
		Company I	1–31	Camp Jossman, **Guimaras, P. I.**
		Company K	1–31	Camp Marahui, **Mindanao, P. I.**
	February	Battalion less Companies I, K, and M.	1–29	Manila, P. I.
		Company I	1–29	Camp Jossman, **Guimaras, P. I.**
		Company K	1–29	Camp Marahui, **Mindanao, P. I.**
		Company M	1–24	Manila, P. I.
			25–29	Fort William **McKinley, Rizal,** Luzon, P. I.
	March	Battalion less Companies I, K, and M.	1–31	Manila, P. I.
		Company I	1–31	Camp Jossman, Guimaras, **P. I.**
		Company K	1–31	Camp Marahui, Mindanao, **P. I.**
		Company M	1–12	Fort William McKinley, **Rizal,** Luzon, P. I.
			13–31	Manila, P. I.
	April	Battalion less Companies I, K, and L.	1–30	Do.
		Company I	1–30	Camp Jossman, Guimaras, **P. I.**
		Company K	1–30	Camp Marahui, Mindanao, **P. I.**
		Company L	1– 8	Manila, P. I.
			9–23	Fort William McKinley, **Rizal,** Luzon, P. I.
			24–30	Manila, P. I.
	May	Battalion less Companies I and K.	1–31	Do.
		Company I	1–31	Camp Jossman, Guimaras, P. I.
		Company K	1–15	Camp Marahui, Mindanao, P. I.
			16–31	Camp Pantar, Mindanao, P. I.
	June	Battalion less Companies I and K.	1–30	Manila, P. I.
		Company I	1–30	Camp Jossman, Guimaras, P. I.
		Company K	1–30	Camp Marahui, Mindanao, P. I.
	July	Battalion less Companies I and K.	1–21	Manila, P. I.
			22–31	Fort William McKinley, Rizal, Luzon, P. I.
		Company I	1–31	Camp Jossman, Guimaras, P. I.
		Company K	1–31	Camp Marahui, Mindanao, P. I.
	August	Battalion less Companies I and K.	1–31	Fort William McKinley, Rizal, Luzon, P. I.
		Company I	1–31	Camp Jossman, Guimaras, P. I.
		Company K	1–28	Camp Pantar, Mindanao, P. I.
			29–31	Camp Overton, Mindanao, P. I.
	September	Battalion less Companies I and K.	1–30	Fort William McKinley, Rizal, Luzon, P. I.
		Company I	1–30	Camp Jossman, Guimaras, P. I.
		Company K	1–30	Camp Overton, Mindanao, P. I.
	October	Battalion less Companies I and K.	1–31	Fort William McKinley, Rizal, Luzon, P. I.
		Company I	1– 5	Camp Jossman, Guimaras, P. I.
			6–11	En route to Fort William McKinley, P. I.
			12–31	Fort William McKinley, Rizal, Luzon, P. I.
		Company K	1–31	Camp Overton, Mindanao, P. I.
	Nov. 1 to July 31	Battalion less Company K		Fort William McKinley, Rizal, Luzon, P. I.
1905		Company K		Camp Overton, Mindanao, P. I.
	August	Battalion less Company K	1–12	Fort William McKinley, P. I.
			13–14	Aboard U. S. Army transport *Sheridan*, Mariveles, P. I.
			15–31	En route to United States.

Year	Month	Element	Dates	Station
1905	August	Company K	1-8	Camp Overton, Mindanao, P. I.
			9-12	En route to Manila, P. I.
			13-14	Aboard U. S. Army transport *Sheridan*, Mariveles, P. I.
			15-31	En route to United States.
	September	Battalion	1-13	En route to San Francisco, Calif.
			14-17	The Presidio, San Francisco, Calif.
			18-22	En route to Fort Leavenworth, Kans.
			23-30	Fort Leavenworth, Kans.
1906	Oct. 1 to June 30	do		Do.
	July	Battalion less Company K	1-14	Do.
			15-23	Marched to Fort Riley, Kans.
			24-31	Fort Riley, Kans.
		Company K	1-12	Fort Leavenworth, Kans.
			13-31	Fort Riley, Kans.
	Aug. 1 to Dec. 31	Battalion		Do.
1907	January	do	1-27	Do.
			28-31	Fort Leavenworth, Kans.
	February	Battalion less Company K	1	Do.
			2-5	En route to Newport News, Va.
			6-10	En route to Habana, Cuba.
			11-28	Camp Columbia, Habana, Cuba.
		Company K	1-28	Fort Levenworth, Kans.
	Mar. 1 to May 31	Battalion less Company K		Camp Columbia, Habana, Cuba.
		Company K		Fort Leavenworth, Kans.
	June	Battalion less Company K	1-6	Camp Columbia, Habana, Cuba.
			7-10	En route to Newport News, Va.
			11-15	Abaord U. S. Army transport *Kilpatrick*, Newport News, Va.
			16-19	En route to Fort Leavenworth, Kans.
			20-30	Fort Leavenworth, Kans.
		Company K	1-30	Do.
	July 1 to Aug. 31	Battalion		Do.
	September	Battalion less Company K	1	En route to Fort Riley, Kans.
			2-30	Fort Riley, Kans.
		Company K	1-30	Fort Leavenworth, Kans.
	October	Battalion less Company K	1-11	Fort Riley, Kans.
			12	En route to Fort Leavenworth, Kans.
			13-31	Fort Leavenworth, Kans.
		Company K	1-31	Do.
1908	Nov. 1 to June 30	Battalion		Do.
	July	Battalion less Companies K and M.	1-26	Do.
			27-31	Marched to North Topeka enroute to Fort Riley, Kans.
		Companies K and M	1-28	Fort Leavenworth, Kans.
			29-31	En route to Dale Creek, Wyo.
	August	Battalion less Companies K and M.	1-6	Marched to Fort Riley, Kans.
			7-31	Fort Riley, Kans.
		Companies K and M	1	En route to Camp Emmet Crawford, Wyo.
			2-31	Camp Emmet Crawford near Fort D. A. Russell, Wyo.
	September	Battalion less Companies K and M.	1-6	Fort Riley, Kans.
			7-14	En route to St. Joseph, Mo.
			15-27	St. Joseph, Mo.
			28	En route to Fort Leavenworth, Kans.
			29-30	Fort Leavenworth, Kans.
		Companies K and M	1-13	En route to Fort Leavenworth, Kans.
			14-30	Fort Leavenworth, Kans.
1909	Oct. 1 to May 31	Battalion		Do.
	June	Battalion less Company L	1-30	Do.
		Company L	1-29	Do.
			30	En route to Toledo, Ohio.
	July	Battalion less Company L	1-31	Fort Leavenworth, Kans.
		Company L	1-10	Camp William H. Taft, Toledo, Ohio.
			11-13	En route to Fort Leavenworth, Kans.
			14-31	Fort Leavenworth, Kans.

Year	Month	Element	Dates	Station
1909	August	Battalion less Companies I and K.	1-31	Fort Leavenworth, Kans.
		Company I	1-14	Do.
			15-31	Reconnaissance test through State of Missouri.
		Company K	1-23	Fort Leavenworth, Kans.
			24-31	Marching to Des Moines, Iowa.
	September	Battalion less Companies I and K.	1-30	Fort Leavenworth, Kans.
		Company I	1-13	Reconnaissance test through State of Missouri.
			14-30	Fort Leavenworth, Kans.
		Company K	1-17	Marching to Des Moines, Iowa.
			18-27	Des Moines, Iowa.
			28	En route to Fort Leavenworth, Kans.
			29-30	Fort Leavenworth, Kans.
1910	Oct. 1 to Mar. 31	Battalion		Do.
	April	Battalion less Company M	1-30	Do.
		Company M	1-29	Do.
			30	En route to Fort D. A. Russell, Wyo.
	May	Battalion less Company M	1-31	Fort Leavenworth, Kans.
		Company M	1- 2	En route to Fort D. A. Russell, Wyo.
			3-11	Fort D. A. Russell, Wyo.
			12-14	Marched to Crow Creek Forest Reserve, Wyo.
			15-31	Crow Creek Forest Reserve, Wyo.
	June	Battalion less Companies L and M.	1-30	Fort Leavenworth, Kans.
		Company L	1-26	Do.
			27-28	En route to Chicago, Ill.
			29-30	Camp J. M. Dickinson, Chicago, Ill.
		Company M	1-30	Crow Creek Forest Reserve (35 miles from Fort D. A. Russell, Wyo.).
	July	Battalion less Companies I and M.	1-27	Fort Leavenworth, Kans.
			28-31	Marching enroute to Fort Riley, Kans.
		Company I	1-31	Fort Leavenworth, Kans.
		Company M	1-31	Camp E. S. Otis, Wyo.
	August	Battalion less Companies I and M.	1-12	Marching to Fort Riley, Kans.
			13-31	Fort Riley, Kans.
		Company I	1-24	Marching to Mexico, Mo.
			25-31	Fort Benjamin Harrison, Ind.
		Company M	1-21	Camp E. S. Otis, Wyo.
			22	Marched to Fort D. A. Russell, Wyo.
			23-31	Fort D. A. Russell, Wyo.
	September	Battalion less Companies I and M.	1-14	Fort Riley, Kans.
			15	En route to Fort Leavenworth, Kans.
			16-30	Fort Leavenworth, Kans.
		Company I	1-30	Fort Benjamin Harrison, Ind.
		Company M	1-30	Fort D. A. Russell, Wyo.
	October	Battalion less Companies I and M.	1-31	Fort Leavenworth, Kans.
		Company I	1	Fort Benjamin Harrison, Ind.
			2	En route to Fort Leavenworth, Kans.
			3-31	Fort Leavenworth, Kans.
		Company M	1-31	Fort D. A. Russell, Wyo.
	Nov. 1 to Feb. 28	Battalion less Company M		Fort Leavenworth, Kans.
1911		Company M		Fort D. A. Russell, Wyo.
	March	Battalion less Company M	1- 8	Fort Leavenworth, Kans.
			9-11	En route to Fort Sam Houston, Tex.
			12-31	Fort Sam Houston, Tex.
		Company M	1- 9	Fort D. A. Russell, Wyo.
			10-14	En route to Fort Sam Houston, Tex.
			15-31	Fort Sam Houston, Tex.
	Apr. 1 to May 31	Battalion		Maneuver Division, San Antonio, Tex. (Fort Sam Houston, Tex.).
	June	Battalion less Companies K and L.	1-26	Do.
			27	Marched to Leon Springs, Tex.

EIGHTH ENGINEER TRAIN (MOUNTED)

The Eighth Engineer Train was organized under the provisions of the Act of Congress approved May 18, 1917, at Camp Stewart, Fort Bliss, Tex., on August 8, 1917, pursuant to First Endorsement A. G. O. 2605788, dated June 9, 1917.

Year	Month	Element	Dates	Station
1917	August	Train	8-31	Camp Stewart, Fort Bliss, Tex.
	September	do	1-30	Do.
	October	do	1-29	Do.
			30	Camp Courchesne, N. Mex.
	November	do	1-29	Do.
			30	Camp Baker, Fort Bliss, Tex.
1918	Dec. 1 to May 31	do		Do.
	June	do	1-23	Do.
			24-30	March to Las Cruces, N. Mex., and return to Camp Baker.
	July	do	1-14	Camp Baker, Fort Bliss, Tex.
			15-22	En route to Camp Head Springs, Mescalero, N. Mex.
			23-31	Camp Head Springs, Mescalero, N. Mex.
	August	do	1-14	Do.
			15-22	En route to Camp Baker, Fort Bliss, Tex.
		do	23-31	Camp Baker, Fort Bliss, Tex.
1919	Sept. 1 to July 31	do		Do.

NOTE.—Engaged in operations against Villista forces in Mexico June 15 and 16, 1919.

Year	Month	Element	Dates	Station
	August	Train	1-16	Camp Baker, Fort Bliss, Tex.
			17-21	En route to Camp Wagner, Cloudcroft, N. Mex.
			22-31	Camp Wagner, Cloudcroft, N. Mex.
	September	do	1-15	Do.
			16-19	En route to Camp Baker, Fort Bliss, Tex.
			20-30	Camp Baker, Fort Bliss, Tex.
1920	Oct. 1 to Feb. 29	do		Do.
	Mar. 1 to June 30	do		Fort Bliss, Tex.
	July	do	1-20	Do.
			21-27	En route to Camp Dickman, Elephant Butte Dam, N. Mex.
			28-31	Camp Dickman, Elephant Butte Dam, N. Mex.
	August	do	1-3	Do.
			4-10	En route to Fort Bliss, Tex.
			11-31	Fort Bliss, Tex.
1921	Sept. 1 to May 31	do		Do.
	June	do	1-15	Do.

NOTE.—The 8th Engineer Train was demobilized June 15, 1921; officers and enlisted men transferred to 8th Engineers (Mounted) and the final return rendered same date per authority 2d endorsement, Headquarters 8th Corps Area, dated June 6, 1921.

Year	Month	Element	Dates	Station
1913	January	Headquarters and Company L	1-31	Fort Santiago, Manila, P. I.
		Company I	1-31	Fort De Russy, T. H.
		Company K	1-31	Fort Mills, Corregidor, P. I.
		Company M	1-31	Fort Leavenworth, Kans.
	February	Headquarters and Company L	1-28	Fort Santiago, Manila, P. I.
		Company I	1-28	Fort De Russy, T. H.
		Company K	1-28	Fort Mills, Corregidor, P. I.
		Company M	1-24	Fort Leavenworth, Kans.
			25-28	En route to Texas City, Tex.
	Mar. 1 to Apr. 30	Headquarters and Company L		Fort Santiago, Manila, P. I.
		Company I		Fort De Russy, T. H.
		Company K		Fort Mills, Corregidor, P. I.
		Company M		Texas City, Tex.
	May	Headquarters and Company L	1-31	Fort Santiago, Manila, P. I.
		Company I	1-12	Fort De Russy, T. H.
			13-31	Fort Shafter, T. H.
		Company K	1-31	Fort Mills, Corregidor, P. I.
		Company M	1-31	Texas City, Tex.
	June	Headquarters	1-30	Fort Santiago, Manila, P. I.
		Company I	1-30	Fort Shafter, T. H.
		Company K	1-30	Fort Mills, Corregidor, P. I.
		Company L	1- 4	Fort Santiago, Manila, P. I.
			5-30	Fort Mills, Corregidor, P. I.
		Company M	1-30	Texas City, Tex.
	July 1 to Aug. 31	Headquarters		Fort Santiago, Manila, P. I.
		Company I		Fort Shafter, T. H.
		Companies K and L		Fort Mills, Corregidor, P. I.
		Company M		Texas City, Tex.
	September	Headquarters	1-30	Fort Santiago, Manila, P. I.
		Company I	1-30	Fort Shafter, T. H.
		Company K	1-30	Fort Mills, Corregidor, P. I.
		Company L	1- 2	Do.
			3-30	Camp Eldridge, Laguna, P. I.
		Company M	1-30	Texas City, Tex.
	October	Headquarters	1-31	Fort Santiago, Manila, P. I.
		Company I	1-31	Fort Shafter, T. H.
		Company K	1-31	Fort Mills, Corregidor, P. I.
		Company L	1	En route to Fort Mills, Corregidor, P. I.
			2-31	Fort Mills, Corregidor, P. I.
		Company M	1-31	Texas City, Tex.
	Nov. 1 to Dec. 31	Headquarters		Fort Santiago, Manila, P. I.
		Company I		Fort Shafter, T. H.
		Companies K and L		Fort Mills, Corregidor, P. I.
		Company M		Texas City, Tex.
1914	January	Headquarters	1-31	Fort Santiago, Manila, P. I.
		Company I	1-31	Fort Shafter, T. H.
		Company K	1-31	Fort Mills, Corregidor, P. I.
		Company L	1-22	Do.
			23-31	Maneuvers, Batangas Province, P. I.
		Company M	1-31	Texas City, Tex.
	February	Headquarters	1-28	Fort Santiago, Manila, P. I.
		Company I	1-28	Fort Shafter, T. H.
		Company K	1-28	Fort Mills, Corregidor, P. I.
		Company L	1-28	Maneuvers.
		Company M	1-28	Texas City, Tex.
	Mar. 1 to June 30	Headquarters		Fort Santiago, Manila, P. I.
		Company I		Fort Shafter, T. H.
		Companies K and L		Fort Mills, Corregidor, P. I.
		Company M		Texas City, Tex.
	July	Headquarters	1-31	Fort Santiago, Manila, P. I.
		Company I	1-31	Fort Shafter, T. H.
		Companies K and L	1-31	Fort Mills, Corregidor, P. I.
		Company M	1-20	Texas City, Tex.
			21-31	Fort Crockett, Tex.
	August	Headquarters	1-31	Fort Santiago, Manila, P. I.
		Company I	1-31	Fort Shafter, T. of H.
		Company K	1-31	Fort Mills, Corregidor, P. I.
		Company L	1-30	Do.
			31	En route to Camp Eldridge, Laguna, P. I.
		Company M	1-20	Fort Crockett, Tex.
			21-31	Texas City, Tex.
	September	Headquarters	1-30	Fort Santiago, Manila, P. I.
		Company I	1-30	Fort Shafter, T. H.
		Company K	1-30	Fort Mills, Corregidor, P. I.
		Company L	1-22	Camp Eldridge, Laguna, P. I.
			23-30	Fort Mills, Corregidor, P. I.
		Company M	1-30	Texas City, Tex.
	October	Headquarters	1-31	Fort Santiago, Manila, P. I.
		Company I	1-13	Fort Shafter, T. H.
			14-28	Schofield Barracks, T. H.
			29-31	Fort Shafter, T. H.

Year	Month	Element	Dates	Station
1914	October	Companies K and L	1-31	Fort Mills, Corregidor, P. I.
		Company M	1- 8	Texas City, Tex.
			9-31	Dallas, Tex.
	November	Headquarters	1-30	Fort Santiago, Manila, P. I.
		Company I	1-30	Fort Shafter, T. H.
		Companies K and L	1-30	Fort Mills, Corregidor, P. I.
		Company M	1-10	Dallas, Tex.
	Dec. 1 to Jan. 31	Headquarters		Fort Santiago, Manila, P. I.
		Company I		Fort Shafter, T. H.
1915		Companies K and L		Fort Mills, P. I.
		Company M		Texas City, Tex.
	February	Headquarters	1-17	Fort Santiago, Manila, P. I.
			18-28	Fort Mills, P. I.
		Company I	1-28	Fort Shafter, T. H.
		Companies K and L	1-28	Fort Mills, Corregidor, P. I.
		Company M	1-28	Texas City, Tex.
	March	Battalion less Companies I and M.	1-31	Fort Mills, Corregidor, P. I.
		Company I	1-31	Fort Shafter, T. H.
		Company M	1-31	Texas City, Tex.
	April	Battalion less Companies I and M.	1-30	Fort Mills, Corregidor, P. I.
		Company I	1-30	Fort Shafter, T. H.
		Company M	1-27	Texas City, Tex.
			28-30	En route to Panama from Galveston, Texas, aboard U. S. Army transport *Buford*.
	May	Battalion less Companies I and M.	1-31	Fort Mills, Corregidor, P. I.
		Company I	1-31	Fort Shafter, T. H.
		Company M	1- 4	En route to Canal Zone.
			5-31	Corozal, Canal Zone.
	June 1 to Dec. 31	Battalion less Companies I and M.		Fort Mills, Corregidor, P. I.
		Company I		Fort Shafter, T. H.
		Company M		Corozal, Canal Zone.
1916	January	Headquarters and Company K	1-31	Fort Mills, Corregidor, P. I.
		Company I	1-31	Fort Shafter, T. H.
		Company L	1- 3	Fort Mills, Corregidor, P. I.
			4-31	Fort William McKinley, P. I.
		Company M	1-31	Corozal, Canal Zone.
	Feb. 1 to Mar. 31	Headquarters and Company K		Fort Mills, Corregidor, P. I.
		Company I		Fort Shafter, T. H.
		Company L		Fort William McKinley, P. I.
		Company M		Corozal, Canal Zone.
	April	Headquarters	1-21	Fort Mills, Corregidor, P. I.
			22-30	Fort Santiago, Manila, P. I.
		Company I	1-30	Fort Shafter, T. H.
		Company K	1-30	Fort Mills, Corregidor, P. I.
		Company L	1-30	Fort William McKinley, P. I.
		Company M	1-30	Corozal, Canal Zone.
	May 1 to June 30	Headquarters		Fort Santiago, Manila, P. I.
		Company I		Fort Shafter, T. H.
		Company K		Fort Mills, Corregidor, P. I.
		Company L		Fort William McKinley, P. I.
		Company M		Corozal, Canal Zone.
	July	Headquarters	1-31	Fort Santiago, Manila, P. I.
		Company I	1-31	Fort Shafter, T. H.
		Company K	1-31	Fort Mills, Corregidor, P. I.
		Company L	1-31	Fort William McKinley, P. I.
		Company M	1-26	Corozal, Canal Zone.
			27	Became Company E, 3d Regiment of Engineers, G. O. No. 22, War Department, 1916.

NOTE.—See 3d Regiment of Engineers.

THE ENGINEER BAND

The Engineer Band was organized under authority of General Order No. 22, War Department, 1901, at Fort Totten, Willetts Point, N. Y., on February 26, 1901.

February 26, 1901, to September 30, 1901, Fort Totten, Willettes Point, N. Y.

October 1, 1901, to July 10, 1919, Washington Barracks, D. C.

July 11, 1919, to August 6, 1919, Camp A. A. Humphreys, Va.

NOTE.—Personnel of the Engineer Band was transferred to the Fifth Regiment of Engineers on August 6, 1919, in accordance with paragraph 16, S. O. No. 218, Camp A. A. Humphreys, Va., dated August 6, 1919.

FIRST ENGINEERS

The First Regiment of Engineers, less Company D (Redesignated Company D First Regiment at Plattsburg Barracks, N.Y., July 1, 1916) was organized at Fort Sam Houston, Texas, on July 1, 1916, under the provisions of the Act of Congress approved June 3, 1916, and pursuant to General Order No. 22, War Department, 1916, and General Order No. 31, Headquarters First Battalion of Engineers. Headquarters and Companies A, B, C, and D, First Battalion of Engineers became Headquarters and Companies A, B, E, D of the First Regiment of Engineers, respectively. Company C First Regiment was formed by transfers from Companies A and B, First Battalion of Engineers and Company F was formed by transfers from Companies C and D, First Battalion of Engineers.

Year	Month	Element	Dates	Station
1916	July	Headquarters and 1st Battalion less Companies A and C.	1-12	Fort Sam Houston, Tex.
			13	En route to Fort Brown, Tex.
			14-31	Fort Brown, Tex.
		Company A	1-31	Do.
		Company C	1-12	Fort San Houston, Tex.
			13	En route to Laredo, Tex.
			14-31	Laredo, Tex. (Fort McIntosh).
		2d Battalion less Company D	1-12	Fort Sam Houston, Tex.
			13	En route to Eagle Pass, Tex.
			14-31	Eagle Pass, Tex.
		Company D	1-31	Plattsburg Barracks, N. Y.
	Aug. 1 to Sept. 30	Regiment less 2d Battalion and Company C.		Fort Brown, Tex.
		2d Battalion less Company D		Eagle Pass, Tex.
		Company C		Laredo, Tex. (Fort McIntosh).
		Company D		Plattsburg Barracks, N. Y.
	October	Regiment less 2d Battalion and Company C.	1-31	Fort Brown, Tex.
		2d Battalion less Company D	1-31	Eagle Pass, Tex.
		Company C	1-31	Laredo, Tex. (Fort McIntosh).
		Company D	1- 6	Plattsburg Barracks, N. Y.
			7	En route to Washington, D. C.
			8-31	Washington Barracks, D. C.
	November	Regiment less 2d Battalion and Company C.	1-30	Fort Brown, Tex.
		2d Battalion less Companies D and F.	1-30	Eagle Pass, Tex.
		Company C	1-30	Laredo, Tex. (Fort McIntosh).
		Company D	1-30	Washington Barracks, D. C.
		Company F	1-16	Eagle Pass, Tex.
			17	En route to Fort Sam Houston, Tex.
			18-30	Fort Sam Houston, Tex.
	Dec. 1 to Feb. 28	Regiment less 2d Battalion and Company C.		Fort Brown, Tex.
		2d Battalion less Companies D and F.		Eagle Pass, Tex.
1917		Company C		Laredo, Tex. (Fort McIntosh).
		Company D		Washington Barracks, D. C.
		Company F		Fort Sam Houston, Tex.
	March	Regiment less 2d Battalion and Companies B and C.	1-31	Fort Brown, Tex.
		2d Battalion less Companies D and F.	1-31	Eagle Pass, Tex.
		Company B	1-15	Fort Brown, Tex.
			16-31	Fort Ringold, Tex.
		Company C	1-31	Laredo, Tex.
		Company D	1-31	Washington Barracks, D. C.

Year	Month	Element	Dates	Station
1917	March	Company F	1	Fort Sam Houston, Tex.
			2	En route to Leon Springs, Tex.
			3-31	Leon Springs, Tex.
	April	Regimental Headquarters, Headquarters 1st Battalion, and Company A.	1- 3	Fort Brown, Tex.
			4-11	En route to Washington, D. C.
			12-30	Washington Barracks, D. C.
		Company B	1- 3	Fort Ringgold, Tex.
			4-11	En route to Washington, D. C.
			12-30	Washington Barracks, D. C.
		Company C	8	En route to Washington, D. C.
			9-30	Washington Barracks, D. C.
		Company D	1-30	Do.
		Company E and Headquarters 2d Battalion.	4	En route to Washington, D. C.
			5-30	Washington Barracks, D. C.
		Company F	1-30	Leon Springs, Tex.
	May [1]	Regiment less Company F	1-31	Washington Barracks, D. C.
		Company F	1-15	Leon Springs, Tex.
			16-31	Washington Barracks, D. C.
	June	Regiment less 1st and 2d Battalions.	1-30	Do.
		1st Battalion	1-10	Do.
			11-26	Belvoir, Va.
			27-30	Washington Barracks, D. C.
		2d Battalion	1-26	Do
			27-30	Belvoir, Va.
	July	Regiment less 1st and 2d Battalions.	1-31	Washington Barracks, D. C.
		1st Battalion	1-15	Do.
			16-18	Practice march to Fort Foote, Md.
			19-31	Washington Barracks, D. C.
		2d Battalion	1- 9	Belvoir, Va.
			10-15	Washington Barracks, D. C.
			16-18	Practice march to Fort Foote, Md.
			19-31	Washington Barracks, D. C.
	August	Regiment	1- 5	Do.
			6	En route to port of embarkation, Hoboken, N. J.
			7-20	Embarked on U. S. cargo transport *Finland* and en route to St. Nazaire, France.
			21-31	In camp at St. Nazaire, France.
	Sept. 1 to July 31	do		American Expeditionary Forces in France and Germany.
1919	August	Headquarters and 2d Battalion	1-20	Engers, Germany.
			21-24	En route to Brest, France.
			25-31	En route to United States aboard U. S. S. *Edellyn*.
		1st Battalion less Company A	1- 4	Engers, Germany.
			5-19	En route to Brest, France.
			20-21	Brest, France.
			22-30	En route to United States aboard U. S. S. *Orazaba*, arrived New York 30th and moved to Camp Mills, L. I., same date.
			31	Camp Mills, L. I.
		Company A	1-31	Coblenz, Germany.
	September	Headquarters and 2d Battalion (less Company D).	1- 4	En route to United States aboard U. S. S. *Edellyn*. Landed at Hoboken, N. J., 4th and moved to Camp Mills, N. Y., same day.
			5- 9	Camp Mills, N. Y.
			10	En route to Washington, D. C.
			11-16	Camp Leach, D. C.
			17	En route to Camp Meade, Md.
			18-30	Camp Meade, Md.
		1st Battalion less Company A	1- 9	Camp Mills, N. Y.
			10	En route to Washington, D. C.
			11-16	Camp Leach, D. C.
			17	En route to Camp Meade, Md.
			18-30	Camp Meade, Md.
		Company A	1-30	Coblenz, Germany.

---

[1] Pursuant to G. O. 62, War Department, 1917, and instructions contained in letter Headquarters Eastern Department, dated May 15, 1917, and paragraph 5, S. O. 71, dated May 16, 1917, the 6th and 7th U. S. Engineers were created by the transfer of the commissioned and enlisted personnel of Companies C and D of the 1st U. S. Engineers to the 6th Engineers; and Company E and Company F to the 7th U. S. Engineers. Two-thirds of the enlisted personnel of the noncommissioned staff, Headquarters Detachment, 1st U. S. Engineers, were transferred to the new organizations. The new companies (C, D, E, and F) of the 1st U. S. Engineers were created by the transfer of commissioned and enlisted personnel from Company A to Companies C and D and Company B to Companies E and F.

Year	Month	Element	Dates	Station
1919	**September**	Company D	1–4	En route to United States aboard U. S. S. *Edellyn*. Landed at Hoboken, N. J., 4th and moved to Camp Mills, N. Y., same day.
			5– 9	Camp Mills, N. Y.
			10	En route to Washington, D. C.
			11–16	Camp Leach, D. C.
			17	En route to Camp Meade, Md.
			18–28	Camp Meade, Md.
			29	En route to Camp Humphreys, Va.
			30	Camp Humphreys, Va.
	October	Regiment less Companies A and D.	1	Camp Meade, Md.
			2– 3	En route to Camp Zachary Taylor, Ky.
			4–81	Camp Zachary Taylor, Ky.
		Company A	1–31	Coblenz, Germany.
		Company D	1–15	Camp Humphreys, Va.
			16	En route to Hoboken, N. J., and boarded U. S. Army transport *President Grant*.
			17	Aboard transport at Hoboken, N. J.
			18–30	En route to Brest, France.
			31	Debarked at Brest, France.
	November	Regiment less Companies A, B, and D.	1–30	Camp Zachary Taylor, Ky.
		Company A	1–30	Coblenz, Germany.
		Company B	1–21	Camp Zachary Taylor, Ky.
			22–30	Camp Humphreys, Va.
		Company D	1– 4	Brest, France.
			5–9	En route to Thur, Germany.
			10–15	Thur, Germany.
			16	En route to Meisenheim, Germany.
			17–30	Meisenheim, Germany.
	December	Regiment less Companies A, B, and D.	1–31	Camp Zachary Taylor, Ky.
		Company A	1–31	Coblenz, Germany.
		Company B	1–18	Camp Humphreys, Va.
			19	En route to Hoboken, N. J.
			20–28	En route to Antwerp, Belgium, aboard U. S. Army transport *Northern Pacific*.
			29–30	Debarked and en route to Coblenz, Germany.
			31	Fortress Asterstein near Coblenz, Germany.
		Company D	1–31	Meisenheim, Germany.
1920	January	Regiment less Companies A, B, and D.	1–31	Camp Zachary Taylor, Ky.
		Company A	1–31	Coblenz, Germany.
		Company B	1–31	Fortress Asterstein, Germany.
		Company D	1–31	Meisenheim, Germany.
	February	Regiment less Companies A, B, and D.	1–29	Camp Zachary Taylor, Ky.
		Company A	1–29	Coblenz, Germany.
		Company B	1– 8	Fortress Asterstein, Germany.
			9–29	Coblenz, Germany.
		Company D	1–29	Meisenheim, Germany.
	Mar. 1 to June 30	Regiment less Companies A, B, and D.	--------	Camp Zachary Taylor, Ky.
		Companies A and B	--------	Coblenz, Germany.
		Company D	--------	Meisenheim, Germany.
	July	Regiment less Companies A, B, and D.	1–31	Camp Zachary Taylor, Ky.
		Companies A and B	1–31	Coblenz, Germany.
		Company D	1– 8	Meisenheim, Germany.
			9–10	En route to Ransbach, Germany.
			11–31	Ransbach, Germany.
	August	Regiment less Companies A, B, D, and E.	1–23	Camp Zachary Taylor, Ky.
			24–25	En route to Camp Dix, N. J.
			26–31	Camp Dix, N. J.
		Companies A and B	1–31	Coblenz, Germany.
		Company D	1– 5	Ransbach, Germany.
			6–31	Meisenheim, Germany.
		Company E	1	Camp Zachary Taylor, Ky.
			31	1st Division Military Circus, Chicago.
	September	Regiment less Companies A, B, D, and E.	1–30	Camp Dix, N. J.
		Companies A and B	1–30	Coblenz, Germany.
		Company D	1–30	Meisenheim, Germany.
		Company E	1–	1st Division Military Circus.
			–30	Camp Dix, N. J.

Year	Month	Element	Dates	Station
1920	October	Regiment less Companies A, B, and D.	1-31	Camp Dix, N. J.
		Companies A and B	1-31	Coblenz, Germany.
		Company D	1- 3	Meisenheim, Germany.
			4	En route to Coblenz, Germany.
			5-31	Coblenz, Germany.
	Nov. 1 to Dec. 31	Regiment less Companies A, B, and D.		Camp Dix, N. J.
		Companies A, B, and D.		Coblenz, Germany.
1921	January	Headquarters, Hq. & Serv. Company, Companies C, E, F.	1-31	Camp Dix, N. J.
		Companies A, B, D	1-31	Coblenz, Germany.

NOTE.—On January 27 the regiment was reorganized under T/063 P, dated Dec. 13, 1920, the new Headquarters and Service Company being formed of the personnel of the old Headquarters Detachment, the Band and transfers of 31 enlisted men from Company C, 30 from Company E, and 30 from Company F.

Year	Month	Element	Dates	Station
1922	Feb. 1 to Feb. 28	Regiment less Companies A, B, D.		Camp Dix, N. J.
	March	Regiment less Companies A, B, D.	1-31	Do.
		Companies A, B	1-19	Coblenz, Germany.
			20-29	En route to United States.
		Company A	29-31	Fort Jay, N. Y.
		Company B	29-31	Miller Field, Staten Island, N. Y.
		Company D	1-31	Coblenz, Germany.
	April	Regiment less Companies A, B, D.	1-30	Camp Dix, N. J.
		Company A	1-30	Fort Jay, N. Y.
		Company B	1-30	Miller Field, Staten Island, N. Y.
		Company D	1-30	Coblenz, Germany.
	May	Regiment less Companies A, B, D.	1-22	Camp Dix, N. J.
			23-27	En route to Ft. Du Pont, Del.
			28-31	Fort Du Pont, Del.
		Company A	1-30	Fort Jay, N. Y.
		Company B	1-20	Miller Field, Staten Island, N. Y.
			21-22	En route to Camp Dix, N. J.
			23-27	En route to Fort Mott, N. J.
			28-31	Fort Mott, N. J.
		Company D	1-30	En route from Coblenz and stationed at Fort Jay, N. Y.
	June	Regiment less Companies A, B, D.	1-30	Fort Du Pont, Del.
		Company A	1-30	Fort Jay, N. Y.
		Company B	1-30	Fort Mott, N. J.
		Company D	1- 5	Fort Jay, N. Y.
			6-30	Fort Du Pont, Del.
	July	Regiment less Companies A and B.	1-31	Do.
		Company A	1- 5	Fort Jay, N. Y.
			6	En route to Camp Dix, N. J.
			7-31	Camp Dix, N. J.
		Company B	1-31	Fort Mott, N. J.
	August	Regiment less Companies A and B.	1-31	Fort Du Pont, Del.
		Company A	1-31	Camp Dix, N. J.
		Company B	1-31	Fort Mott, N. J.
	September	Regiment less Companies A and B.	1-30	Fort Du Pont, Del.
		Company A	1-25	Camp Dix, N. J.
			26	En route to Fort Mott, N. J.
			27-30	Fort Mott, N. J.
		Company B	1-30	Do.
1923	Oct. 1 to Apr. 30	Regiment less Companies A and B.		Fort Du Pont, Del.
		Companies A and B		Fort Mott, N. J.
	May	Regiment less Companies A, B, F.	1-31	Fort Du Pont, Del.
		Company A	1-14	Fort Mott, N. J.
			15-31	Camp Devens, Mass.
		Company B	1- 7	Fort Mott, N. J.
			8-31	Camp Dix, N. J.
		Company F	1-15	Fort Du Pont, Del.
			16-31	Camp Meade, Md.
	June 1 to Aug. 30.	Regiment less Companies A, B, F.		Fort Du Pont, Del.
		Company A		Camp Devens, Mass.
		Company B		Camp Dix, N. J.
		Company F		Camp Meade, Md.
	September	Regiment less Companies A, B, F.	1-30	Fort Du Pont, Del.

Year	Month	Element	Dates	Station
1923	September	Company A	1-25	Camp Devens, Mass.
			26-30	Fort Mott, N. J.
		Company B	1-30	Do.
		Company F	1-17	Camp Meade, Md.
			17-30	Fort Du Pont, Del.
	Oct. 1 to	Regiment less Companies A and B.	--------	Do.
1924	Mar. 31	Companies A and B	--------	Fort Mott, N. J.
	April	Regiment less Companies A and B.	1-30	Fort Du Pont, Del.
		Company A	1- 6	Fort Mott, N. J.
			7-30	Camp Dix, N. J.
		Company B	1-30	Fort Mott, N. J.
	May	Regiment less Companies A, B, D.	1-31	Fort Du Pont, Del.
		Company A	1-31	Camp Dix, N. J.
		Company B	1-31	Fort Mott, N. J.
		Company D	1-31	Camp Devens, Mass.
	June	Regiment less Companies A, B, D.	1-30	Fort Du Pont, Del.
		Company A	1- 3	Camp Dix, N. J.
			4- 9	Fort Mott, N. J.
			10-30	Fort Du Pont, Del.
		Company B	1-30	Fort Mott, N. J.
		Company D	1-30	Camp Devens, Mass.
	July	Regiment less Companies B and D.	1-31	Fort Du Pont, Del.
		Company B	1-31	Fort Mott, N. J.
		Company D	1-31	Camp Devens, Mass.
	August	Regiment less Companies B, D, E.	1-31	Fort Du Pont, Del.
		Company B	1-31	Fort Mott, N. J.
		Company D	1-31	Camp Devens, Mass.
		Company E	1-20	Fort Du Pont, Del.
			20-31	Camp Dix, N. J.
	September	Regiment less Companies B, D, E.	1-30	Fort Du Pont, Del.
		Company B	1-30	Fort Mott, N. J.
		Company D	1-15	Camp Devens, Mass.
			16-30	Fort Du Pont, Del.
		Company E	1-30	Camp Dix, N. J.
	October	Regiment less Companies A, B, E.	1-31	Fort Du Pont, Del.
		Company A	1- 8	Do.
			9-31	Fort Mott, N. J.
		Company B	1- 8	Do.
			9-31	Fort Du Pont, Del.
		Company E	1-30	Camp Dix, N. J.
			31	Fort Du Pont, Del.
	November	Regiment less Companies A and B.	1-30	Do.
		Company A	1-30	Fort Mott, N. J.
		Company B	1-13	Fort Du Pont, Del.
			14-30	Fort Mott, N. J.
	Dec. 1 to	Regiment less Companies A and B.	--------	Fort Du Pont, Del.
1925	Mar. 31	Companies A and B	--------	Fort Mott, N. J.
	April	Regiment less Companies A and B.	1-30	Fort Du Pont, Del.
		Company A	1-22	Fort Mott, N. J.
			23-30	Fort Du Pont, Del.
		Company B	1-30	Fort Mott, N. J.
	May	Regiment less Companies A, B, D.	1-31	Fort Du Pont, Del.
		Company A	1-22	Do.
			23-31	Fort Mott, N. J.
		Company B	1- 4	Do.
			5-31	Fort Totten, N. Y.
		Company D	1-18	Fort Du Pont, Del.
			19-31	Camp Devens, Mass.
	June 1 to Aug. 30	Regiment less Companies A, B, D.	--------	Fort Du Pont, Del.
		Company A	--------	Fort Mott, N. J.
		Company B	--------	Fort Totten, N. Y.
		Company D	--------	Camp Devens, Mass.
	September	Regiment less Companies A, B, D.	1-30	Fort Du Pont, Del.
		Company A	1-25	Fort Mott, N. J.
			26-30	Fort Hancock, N. J.
		Company B	1-16	Fort Totten, N. Y.
			17-30	Fort Hancock, N. J.
		Company D	1- 9	Camp Devens, Mass.
			10-30	Fort Du Pont, Del.

Year	Month	Element	Dates	Station
1925	October	Regiment less Companies A, B, and 1st Battalion headquarters.	1-31	Fort Du Pont, Del.
		Company A and 1st Battalion headquarters.	1-30	Fort Hancock, N. J.
			31	Camp Dix, N. J.
		Company B	1-31	Fort Hancock, N. J.
	November	Regiment less Companies A, B, E, and 1st Battalion headquarters.	1-30	Fort Du Pont, Del.
		Company A and 1st Battalion headquarters.	1-13	Camp Dix, N. J.
			14-30	Fort Hancock, N. J.
		Company B	1-30	Do.
		Company E	1- 3	Fort Du Pont, Del.
			4-14	Tullytown, Pa.
			15-30	Fort Du Pont, Del.
	Dec. 1 to	Regiment less Companies A, B, and 1st Battalion headquarters.	--------	Do.
1926	May 31	Companies A, B, and 1st Battalion headquarters.	--------	Fort Hancock, N. J.
	June	Regiment less Companies A, B, and 1st Battalion headquarters.	1-30	Fort Du Pont, Del.
		Company A and 1st Battalion headquarters.	1-30	Fort Hancock, N. J.
		Company B	1-10	Do.
			11-18	Camp Dix, N. J.
			19-30	Fort Hancock, N. J.
	July	Regiment less Companies A, B, D, and 1st Battalion headquarters.	1-31	Fort Du Pont, Del.
		Company A and 1st Battalion headquarters.	1-31	Fort Hancock, N. J.
		Company B	1- 2	Do.
			3-31	Camden, N. J.
		Company D	1-21	Fort Du Pont, Del.
			22-31	Camp Dix, N. J.
	August	Regiment less Companies A, B, D, and 1st Battalion headquarters.	1-31	Fort Du Pont, Del.
		Company A	1-12	Fort Hancock, N. J.
			13-31	Camp Dix, N. J.
		Company B	1-31	Camden, N. J.
		Company D	1-31	Camp Dix, N. J.
		1st Battalion headquarters	1-31	Fort Hancock, N. J.
	September	Regiment less Companies A, B, D, and 1st Battalion headquarters.	1-30	Fort Du Pont, Del.
		Company A	1-30	Camp Dix, N. J.
		Company B	1- 8	Camden, N. J.
			9-30	Fort Hancock, N. J.
		Company D	1-21	Camp Dix, N. J.
			22-30	Fort Du Pont, Del.
		1st Battalion headquarters	1-30	Fort Hancock, N. J.
	October	Regiment less Companies A, B, and 1st Battalion headquarters.	1-31	Fort Du Pont, Del.
		Company A	1- 9	Camp Dix, N. J.
			10-31	Fort Hancock, N. J.
		Company B and 1st Battalion headquarters.	1-31	Do.
	November	Regiment less Companies A, B, C, and 1st Battalion headquarters.	1-30	Fort Du Pont, Del.
		Companies A, B, and 1st Battalion headquarters.	1-30	Fort Hancock, N. J.
		Company C	1- 5	Fort Du Pont, Del.
			6-20	Tullytown, Pa.
			21-30	Fort Du Pont, Del.
	Dec. 1 to	Regiment less Companies A, B, and 1st Battalion headquarters.	--------	Do.
1927	June 30	Companies A, B, and 1st Battalion headquarters.	--------	Fort Hancock, N. J.
	July	Regiment less Companies A, B, and 1st Battalion headquarters.	1-31	Fort Du Pont, Del.
		Companies A and B	1-14	Fort Hancock, N. J.
			15-17	Fort Du Pont, Del.
			18-31	Fort Hancock, N. J.
		1st Battalion headquarters	1-31	Do.

Year	Month	Element	Dates	Station
1927	August	Regiment less Companies A, B, and 1st Battalion headquarters.	1-31	Fort Du Pont, Del.
		Company A and 1st Battalion headquarters.	1-24	Fort Hancock, N. J.
			25-27	En route to Camp Dix, N. J.
			28-31	Camp Dix, N. J.
		Company B	1- 2	Fort Hancock, N. J.
			3-31	Camp Dix, N. J.
	September	Regiment less Companies A, B, and 1st Battalion headquarters.	1-30	Fort Du Pont, Del.
		Companies A, B, and 1st Battalion headquarters.	1-30	Camp Dix, N. J.
	October	Regiment less Companies A, B, and 1st Battalion headquarters.	1-31	Fort Du Pont, Del.
		Companies A, B, and 1st Battalion headquarters.	1-30	Camp Dix, N. J.
			31	Fort Hancock, N. J.
	Nov. 1 to	Regiment less Companies A, B, and 1st Battalion headquarters.	--------	Fort Du Pont, Del.
1928	Apr. 30	Companies A, B, and 1st Battalion headquarters.	--------	Fort Hancock, N. J.
	May	Regiment less Companies A, B, C, D, and 1st Battalion headquarters.	1- 4	En route to Camp Dix, N. J.
			5-31	Camp Dix., N. J.
		Companies A, B, and 1st Battalion headquarters.	1-31	Do.
		Company C	1- 3	Fort Du Pont, Del.
			4-31	Camp Dix, N. J.
		Company D	1-31	Fort Du Pont, Del.
	June	Regiment less Companies B, C, D, and 1st Battalion headquarters.	1-15	Camp Dix, N. J.
			16-30	Fort Du Pont, Del.
		Company B and 1st Battalion headquarters.	1-15	Camp Dix, N. J.
			16-30	Fort Hancock, N. J.
		Company C	1-15	Camp Dix, N. J.
			16-19	En route to Fort Du Pont, Del.
			20-30	Fort Du Pont, Del.
		Company D	1-30	Do.
	July	Regiment less Companies B, C, and 1st Battalion headquarters.	1-31	Do.
		Company B and 1st Battalion headquarters.	1-31	Fort Hancock, N. J.
		Company C	1	Fort Du Pont, Del.
			2-31	Fort Leonard Wood, Md.
	August	Regiment less Companies B, C, and 1st Battalion headquarters.	1-31	Fort Du Pont, Del.
		Company B and 1st Battalion headquarters.	1-31	Fort Hancock, N. J.
		Company C	1-31	Fort Leonard Wood, Md.
	September	Regiment less Companies A, B, C, and 1st Battalion headquarters.	1-30	Fort Du Pont, Del.
		Company A	1- 4	Do.
			5-30	Fort Hancock, N. J.
		Company B and 1st Battalion headquarters.	1-30	Do.
		Company C	1-30	Fort Leonard Wood, Md.
	Oct. 1 to	Regiment less Companies A, B, and 1st Battalion headquarters.	--------	Fort Du Pont, Del.
1929	Mar. 31	Companies A, B, and 1st Battalion headquarters.	--------	Fort Hancock, N. J.
	April	Regiment less Companies A, B, C, D, E, F, and 1st Battalion headquarters.	1-25	Fort Du Pont, Del.
			26-30	Camp Dix, N. J.
		Companies A, B, and 1st Battalion headquarters.	1-26	Fort Hancock, N. J.
			27-30	Camp Dix, N. J.
		Company C	1-21	Fort Du Pont, Del.
			23-30	Camp Dix, N. J.
		Company D	1-30	Fort Du Pont, Del.
		Company E	1-11	Do.
			12-30	Camp Dix, N. J.
		Company F	1-23	Fort Du Pont, Del.
			24-30	Camp Dix, N. J.

Year	Month	Element	Dates	Station
1929	May	Regiment less Company D	1-31	Camp Dix, N. J.
		Company D	1-31	Fort Du Pont, Del.
	June	Regiment less Companies A, B, D, and 1st Battalion headquarters.	1-30	Camp Dix, N. J.
		Company A and 1st Battalion headquarters.	1- 7	Do.
			8- 9	En route to Camp Devens, Mass.
			10-30	Camp Devens, Mass.
		Company B	1- 7	Camp Dix, N. J.
			8-30	Fort Hancock, N. J.
		Company D	1-30	Fort Du Pont, Del.
	July	Regiment less Companies A, B, D, and 1st Battalion headquarters.	1-22	Camp Dix, N. J.
			23-31	Fort Du Pont, Del.
		Company A and 1st Battalion Headquarters.	1-31	Camp Devens, Mass.
		Company B	1-31	Fort Hancock, N. J.
		Company D	1-31	Fort Du Pont, Del.
	August	Regiment less Companies A, B, F, and 1st Battalion Headquarters.	1-31	Do.
		Company A and 1st Battalion Headquarters.	1-14	Camp Devens, Mass.
			15-31	Fort Hancock, N. J.
		Company B	1-31	Do.
		Company F	1- 6	Fort Du Pont, Del.
			7-31	Criglersville, Va. (Camp Rapidan).
	September	Regiment less Companies A, B, F, and 1st Battalion Headquarters.	1-30	Fort Du Pont, Del.
		Companies A, B, and 1st Battalion Headquarters.	1-26	Fort Hancock, N. J.
			27-30	Fort Du Pont, Del.
		Company F	1-30	Camp Rapidan, Va.
	October	Regiment less Companies A, B, and F.	1-31	Fort Du Pont, Del.
		Company A	1-11	Do.
			12-14	Army Base, Brooklyn, N. Y.
			15	Company A, 1st Engineers joined the Nicaraguan Survey Battalion on Oct. 15, 1929, as Company A of that battalion without losing its identity as Company A, 1st Engineers.
		Company B	1-31	Fort Du Pont, Del.
			31	Made inactive.
		Company F	1- 5	Camp Rapidan, Va.
			6-31	Fort Du Pont, Del.
	November	Regiment less Companies A and B.	1-30	Do.
		Company A	1-30	W/Nicaraguan Survey Battalion.
		Company B		Inactive.
	December	Regiment less Companies A, B, D.	1-31	Fort Du Pont, Del.
		Company A	1-31	W/Nicaraguan Survey Battalion.
		Company B		Inactive.
		Company D	1- 6	Fort Du Pont, Del.
			7-17	Camp Dix, N. J.
			18-31	Fort Du Pont, Del.
1930	Jan. 1 to Mar. 31	Regiment less Companies A and B.		Do.
		Company A		W/Nicaraguan Survey Battalion.
		Company B		Inactive.
	April	Regiment less Companies A, B, D, E.	1-30	Fort Du Pont, Del.
		Company A	1-30	W/Nicaraguan Survey Battalion.
		Company B		Inactive.
		Company D	1-15	Fort Du Pont, Del.
			16-30	Camp Dix, N. J.
		Company E	1-29	Fort Du Pont, Del.
			30	Camp Dix, N. J.
	May	Regiment less Companies A, B, C, E, F.	1-31	Do.
		Company A	1-31	W/Nicaraguan Survey Battalion.
		Company B		Inactive.
		Company C	1-14	Fort Du Pont, Del.
			15-31	Camp Devens, Mass.
		Company E	1-18	Camp Dix, N. J.
			19-31	Fort Jay, N. J.
		Company F		Made inactive at Fort Du Pont, Del., on May 1, 1930, in accordance with letter A. G. 320.2 Engineer (1-31-30) dated Apr. 8, 1930.

Year	Month	Element	Dates	Station
1930	June	Regiment less Companies A, B, C, E, F.	1-26	Camp Dix, N. J.
			27	Cotoxen Lakes, N. J.
			28	Atsion, N. J.
			29	Weymouth, N. J.
			30	English Creek, N. J.
		Company A	1-30	W/Nicaraguan Survey Battalion.
		Companies B and F		Inactive.
		Company C	1-30	Camp Devens, Mass.
		Company E	1-25	Fort Jay, N. J.
			26	Camp Dix, N. J.
			27	Cotoxen Lakes, N. J.
			28	Atsion, N. J.
			29	Weymouth, N. J.
			30	English Creek, N. J.
	July	Regiment less Companies A, B, C, F.	1- 7	Ocean City, N. J.
			8-31	Fort Du Pont, Del.
		Company A	1-31	W/Nicaraguan Survey Battalion.
		Companies B and F		Inactive.
		Company C	1-31	Camp Devens, Mass.
	August	Regiment less Companies A, B, C, F.	1-31	Fort Du Pont, Del.
		Company A	1-31	W/Nicaraguan Survey Battalion.
		Companies B and F		Inactive.
		Company C	1-15	Camp Devens, Mass.
			16-31	Fort Du Pont, Del.
	Sept. 1 to Mar. 31	Regiment less Companies A, B, F.		Do.
1931		Company A		W/Nicaraguan Survey Battalion.
		Companies B and F		Inactive.
	April	Regiment less Companies A, B, C, D, F, and 2d Battalion Headquarters.	1-30	Fort Du Pont, Del.
		Company A	1-30	W/Nicaraguan Survey Battalion.
		Company C	1-24	Fort DuPont, Del.
			25-30	Fort Hoyle, Md.
		Company D and 2d Battalion Headquarters.	1-27	Fort Du Pont, Del.
			28-30	Camp Dix, N. J.
		Companies B and F		Inactive.
	May	Regiment less all letter Companies and 2d Battalion Headquarters.	1	Fort Du Pont, Del.
			2-31	Camp Dix, N. J.
		Company A	1-31	W/Nicaraguan Survey Battalion.
		Company C	1- 4	Fort Du Pont, Del.
			5-14	Camp Dix, N. J.
			15-30	Washington Crossing, Pa.
		Company D and 2d Battalion Headquarters.	1-31	Camp Dix, N. J.
		Company E	1-22	Fort Du Pont, Del.
			23-31	Camp Dix, N. J.
		Companies B and F		Inactive.
	June	Regiment less Companies A, B, C, and F.	1-18	Camp Dix, N. J.
			19-30	En route to Ocean City, N. J.
		Company A	1-30	W/Nicaraguan Survey Battalion.
		Company C	1-12	Washington Crossing, Pa.
			13-18	Camp Dix, N. J.
			19-30	En route to Ocean City, N. J.
		Companies B and F		Inactive.
	July	Regiment less Companies A, B, F.	1- 2	Ocean City, N. J.
			3-31	Fort DuPont, Del.
		Company A	1-28	W/Nicaraguan Survey Battalion.
			29-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	August	Regiment less 2d Battalion and Company B.	1-31	Fort Du Pont, Del.
		2d Battalion less Company F.	1-20	Do.
			20-31	Camp Dix, N. J.
		Companies B and F		Inactive.
	September	Regiment less 2d Battalion and Company B.	1-30	Fort Du Pont, Del.
		2d Battalion less Company F	1-30	Camp Dix, N. J.
		Companies B and F		Inactive.
	October	Regiment less 1st and 2d Battalions.	1-31	Fort Du Pont, Del.
		1st Batallion less Company B	1- 6	Do.
			7- 9	Aberdeen Proving Grounds, Md.
			10-31	Fort Du Pont, Del.
		2d Battalion less Company F	1-31	Camp Dix, N. J.
		Companies B and F		Inactive.
	November	Regiment less 2d Battalion and Company B.	1-30	Fort Du Pont, Del.
		2d Battalion less Company F	1-30	Camp Dix, N. J.
		Companies B and F		Inactive.
	Dec. 1 to Feb. 29	Regiment less Companies B and F.		Fort Du Pont, Del.
1932		Companies B and F		Inactive.

Year	Month	Element	Dates	Station
1932	March	Regiment less Companies B, F, and Band.	1-16	Fort Du Pont, Del.
			17	En route to Camp Dix, N. J.
			18-31	Camp Dix, N. J.
		Band	1-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	April	Regiment less Companies B, F, and Band.	1-30	Camp Dix, N. J.
		Band	1-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	May	Regiment less Companies B, F, and Band.	1-31	Camp Dix, N. J.
		Band	1-30	Fort Du Pont, Del.
			31	Camp Dix, N. J.
		Companies B and F		Inactive.
	June	Regiment less Companies B and F.	1-30	Camp Dix, N. J.
		Companies B and F		Inactive.
	July	Regiment less Companies B and F.	1-12	En route to Ocean City, N. J.
			13-14	Ocean City, N. J.
			15-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	August	Regiment less Companies B and F.	1-31	Fort Du pont, Del.
		Companies B and F		Inactive.
	September	Regiment less Companies B, E, and F.	1-30	Fort Du Pont, Del.
		Company E	1-20	Do.
			21-30	En route to Fort Benning, Ga.
		Companies B and F		Inactive.
	October	Regiment less Companies B, E, and F.	1-31	Fort Du Pont, Del.
		Company E	1- 3	En route to Fort Benning, Ga.
			4-31	Fort Benning, Ga.
		Companies B and F		Inactive.
	Nov. 1 to Feb. 28	Regiment less Companies B, E, and F.		Fort Du Pont, Del.
		Company E		Fort Benning, Ga.
1933		Companies B and F		Inactive.
	March	Regiment less Companies B, E, F, and Band.	1-30	Fort Du Pont, Del.
			31	Camp Dix, N. J.
		Company E	1- 5	Fort Benning, Ga.
			6-16	En route to Fort Du Pont, Del.
			17-30	Fort Du Pont, Del.
			31	Camp Dix, N. J.
		Band	1-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	April	Regiment less Companies B, F, and Band.	1-30	Camp Dix, N. J.
		Band	1-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	May 1 to June 30	Regiment less Companies B, F, and Band.		Camp Dix, N. J.
		Band		Fort Du Pont, Del.
		Companies B and F		Inactive.
	July	Regiment less Companies B, F, and Band.	1- 2	Camp Dix, N. J.
			3	En route to Fort Du Pont, Del.
			4-31	Fort Du Pont, Del.
		Band	1-31	Do.
		Companies B and F		Inactive.
	August	Regiment less Companies B, F, and Band.	1-31	Fort Du Pont, Del.
		Band	1-31	Camp Dix, N. J.
		Companies B and F		Inactive.
	September	Regiment less Companies B, F, and Band.	1-30	Fort Du Pont, Del.
		Band	1- 4	Camp Dix, N. J.
			5-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	Oct. 1 to Feb. 28	Regiment less Companies B and F.		Fort Du Pont, Del.
1934		Companies B and F		Inactive.
	March	Regiment less 1st Battalion and Companies D and F.	1-31	Fort Du Pont, Del.
		1st Battalion (less Company B) and Company D.	1-27	Do.
			28-31	Camp Dix, N. J.
		Companies B and F		Inactive.
	Apr. 1 to Oct. 31	Regiment less 1st Battalion and Companies D and F.		Fort Du Pont, Del.
		1st Battalion (less Company B) and Company D.		Camp Dix, N. J.
		Companies B and F		Inactive.
	November	Regiment less 1st Battalion and Companies D and F.	1-30	Fort Du Pont, Del.
		1st Battalion (less Companies B and C) and Company D.	1-30	Camp Dix, N. J.

Year	Month	Element	Dates	Station
1934	**November**	Company C	1-26	Camp Dix, N. J.
			27-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	December	Regiment less Companies A, B, D, F, and 1st Battalion Headquarters.	1-31	Fort Du Pont, Del.
		Companies A, D, and 1st Battalion Headquarters.	1-15	Camp Dix, N. J.
			16-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
1935	**Jan. 1 to June 30**	Regiment less Companies B and F.		Fort Du Pont, Del.
		Companies B and F		Inactive.
	July	Regiment less Companies B, C, and F.	1-31	Fort Du Pont, Del.
		Company C	1-10	Do.
			11-12	En route to Pine Camp, N. Y.
			13-31	Pine Camp, N. Y.
		Companies B and F		Inactive.
	August	Regiment less Companies B, C, D, F, and Headquarters 2d Battalion.	1- 3	En route to Pine Camp, N. Y.
			4-31	Pine Camp, N. Y.
		Company C	1-31	Do.
		Company D and Headquarters 2d Battalion.	1-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	September	Regiment less Companies B, D, F, and Headquarters 2d Battalion.	1- 3	Pine Camp, N. Y.
			4- 5	En route to Fort Du Pont, Del.
			6-30	Fort Du Pont, Del.
		Company D and Headquarters 2d Battalion.	1-30	Do.
		Companies B and F		Inactive.
	October	Regiment less Companies B, D, and F.	1-31	Fort Du Pont, Del.
		Company D	1-28	Do.
			29-31	On practice march.
		Companies B and F		Inactive.
	November	Regiment less Companies B, D, and F.	1-30	Fort Du Pont, Del.
		Company D	1-10	On practice march.
			11-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	Dec. 1 to	Regiment less Companies B and F.		Fort Du Pont, Del.
1936	May 31	Companies B and F		Inactive.
	June	Regiment less Companies A, B, and F.	1-30	Fort Du Pont, Del.
		Company A	1-21	Do.
			22-29	Camp Dix, N. J.
			30-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	July 1 to Aug. 31	Regiment less Companies B and F.		Fort Du Pont, Del.
		Companies B and F		Inactive.
	September	Regiment less Companies A, B, D, F; Headquarters 2d Battalion and Band.	1-14	Fort Du Pont, Del.
			15-17	Camp Dix, N. J.
			18-30	Fort Du Pont, Del.
		Company A	1-30	Do.
		Company D	1-15	Do.
			16-30	Pine Camp, N. Y.
		Headquarters 2d Battalion	1-30	Fort Du Pont, Del.
		Band	1-20	Do.
			21-25	Practice march.
			26-30	Fort Du Pont, Del.
		Companies B and F		Inactive.
	October	Regiment less Companies B, D, and F.	1-31	Fort Du Pont, Del.
		Company D	1- 6	Pine Camp, N. Y.
			7-31	Fort Du Pont, Del.
		Companies B and F		Inactive.
	Nov. 1 to Dec. 31	Regiment less Companies B and F.		Fort Du Pont, Del.
		Companies B and F		Inactive.
1937	Jan. 1 to June 30	Regiment less Companies B and F.		Fort Du Pont, Del.
		Companies B and F		Inactive.
	July	Regiment less Companies A, B, and F.	1-31	Fort Du Pont, Del.
		Company A	1- 7	Do.
			8- 9	En route to Fort Devens, Mass.
			10-31	Fort Devens, Mass.
		Companies B and F		Inactive.
	August	Regiment less Companies A, B, D, and F.	1-31	Fort Du Pont, Del.

Year	Month	Element	Dates	Station
1937	August	Company A	1- 2	Fort Devens, Mass.
			3	En route to Fort Du Pont, Del.
			4-31	Fort Du Pont, Del.
		Company D	1-16	Do.
			17-26	Practice march.
			27-31	Fort Du Pont, Del.
		Companies B and F	--------	Inactive.
	September	Regiment less Companies B, C, E, and F.	1-30	Fort Du Pont, Del.
		Company C	1- 3	Do.
			4-14	Maneuvers, Indiantown Gap, Pa.
			15-30	Fort Du Pont, Del.
		Company E	1-15	Do.
			16-30	Maneuvers, Pine Camp, N. Y.
		Companies B and F	--------	Inactive.
	Oct. 1 to Dec. 31	Regiment less Companies B and F.	--------	Fort Du Pont, Del.
		Companies B and F	--------	Inactive.

FIRST ENGINEER TRAIN

The First Engineer Train was organized at Washington Barracks, D. C., June 12, 1917, under the provisions of the Act of Congress approved May 18, 1917, and pursuant to first endorsement Adjutant General's Office 2605788, dated June 9, 1917. Another train of like numerical designation was organized at Leon Springs, Texas, April 4, 1917, and on July 29, 1917, was redesignated Fifth Engineer Train. (See Fifth Engineer Train.)

Year	Month	Element	Dates	Station
1917	June	1st Engineer Train	12-30	Washington Barracks, D. C.
	July	do	1-31	Do.
	August	do	1- 6	Do.
			7-20	Embarked on U. S. Army cargo transport *Jacinto*, Hoboken, N. J., and en route to St. Nazaire, France.
			21-31	In camp at St. Nazaire, France.
  1919	Sept. 1 to July 31	do		American Expeditionary Forces in France and Germany.
	August	do	1-19	Block-Heimbach, Germany.
			20	En route to Engers, Germany.
			21-24	En route to Brest, France.
			25-31	En route to United States aboard U. S. S. *Edellyn*.
	September	do	1- 4	En route to United States aboard U. S. S. *Edellyn*. Landed at Hoboken, N. J., and moved to Camp Mills, N. Y., same day.
		do	5- 9	Camp Mills, N. Y.
			10	En route to Washington, D. C.
			11-16	Camp Leach, D. C.
			17	En route to Camp Meade, Md.
			18-30	Camp Meade, Md.
	October	do	1	Do.
			2- 3	En route to Camp Zachary Taylor, Ky.
			4-31	Camp Zachary Taylor, Ky.
  1920	Nov. 1 to May 31	do		Do.
  1921	June 1 to Apr 4	do		No personnel assigned. Demobilized per Change Sheet No. 22, Apr. 4, 1921. Discontinued as a separate organization Jan. 27, 1921, in accordance with T/O 63P.

SECOND ENGINEERS

The Second Regiment of Engineers, except Companies E and F, was organized at Dublen, Mexico, on August 1, 1916, in accordance with the provisions of the act of Congress approved June 3, 1916, and pursuant to War Department Special Order 144, 1916, and General Order 22, War Department, 1916. The Headquarters of the Second Battalion of Engineers became the Headquarters of the Second Regiment of Engineers. Companies E, F, G, and H, Second Battalion of Engineers, became respectively Companies C, F, A, and B of the Second Regiment of Engineers. Company D, Second Regiment of Engineers, was formed by transfers from Companies E, G, and H, Second Battalion of Engineers. Company E, Second Regiment of Engineers, was formed at Vancouver Barracks, Wash., July 1, 1916, by transfers from Company F, Second Regiment of Engineers.

Year	Month	Element	Dates	Station
1916	July	Headquarters, 2d Battalion	1-31	Vancouver Barracks, Wash.
		Company E	1- 4	Do.
			5-31	En route to and at Calexico, Calif.
		Company F	1-31	Vancouver Barracks, Wash.
	Aug. 1 to Oct. 31	Regiment less Headquarters 2d Battalion, Companies E and F.		With punitive expedition Mexico.
		Headquarters 2d Battalion and Company F.		Vancouver Barracks, Wash.
		Company E		Calexico, Calif.
	November	Regiment less Headquarters 2d Battalion, Companies E, F.	1-30	With punitive expedition Mexico.
		Headquarters 2d Battalion and Company F.	1-30	Vancouver Barracks, Wash.
		Company E	1- 2	Calexico, Calif.
		Company E	3-20	Fort Barry, Calif.
			21-23	Enroute to Vancouver Barracks, Wash.
			24-30	Vancouver Barracks, Wash.
	Dec. 1 to Jan. 31	Regiment less Headquarters 2d Battalion, Companies E and F.		With punitive expedition Mexico.
1917		2d Battalion less Company D		Vancouver Barracks, Wash.
	February	Regiment less Headquarters 2d Battalion, Companies E and F.	1- 4	With punitive expedition Mexico.
			5	En route from Palomas, Mexico, to Columbus, N. Mex.
			6- 7	Columbus, N. Mex.
			8- 9	En route to Camp Stewart, El Paso, Tex.
			10-28	Camp Stewart, El Paso, Tex.
		2d Battalion less Company D	1-28	Vancouver Barracks, Wash.
	March	Regiment less Headquarters 2d Battalion, Companies E and F.	1-12	Camp Stewart, El Paso, Tex.
			13-31	Camp Newton D. Baker, El Paso, Tex.
		2d Battalion less Company D	1-31	Vancouver Barracks, Wash.
	April	Regiment less Headquarters 2d Battalion, Companies E and F.	1-30	Camp Newton D. Baker, El Paso, Tex.
		2d Battalion less Company D	1-30	Vancouver Barracks, Wash.
	May	Regiment less Headquarters 2d Battalion, Companies E and F.	1-20	Camp Newton D. Baker, El Paso, Tex.
		2d Battalion less Company D	1-20	Vancouver Barracks, Wash.
		Regiment	21-31	Camp Newton D. Baker, El Paso, Tex.

NOTE.—Regiment reorganized May 31, 1917, in accordance with the provisions of War Department General Order No. 62, 1917. Companies A and B were organized into the 2d Regiment of Engineers at El Paso, Tex. Companies E and F, 2d Engineers were organized into the 4th Regiment of Engineers at Vancouver Barracks, Wash. Companies C and D, 2d Engineers, were organized into the 5th Regiment of Engineers at El Paso, Tex.

Year	Month	Element	Dates	Station
1917	June 1 to July 31	Regiment		Camp Newton D. Baker, El Paso, Tex.
	August	do	1-21	Do.
			22-28	En route to Washington, D. C.
			29-31	Camp American University, D. C.
	September	do	1- 9	Do.
			10-13	Aboard R. M. S. *Carpathia* enroute to Halifax, Nova Scotia.
			14-20	Aboard R. M. S. *Carpathia*, Halifax, Nova Scotia.
			21-31	Aboard R. M. S. *Carpathia* enroute to Glasgow, Scotland.
	October	do	1	Do.
			2	Disembarked and en route to Southampton, England.
			3- 4	Southampton, England.
			5- 6	En route to Havre, France.
			7-31	With American Expeditionary Force in France.
1919	Nov. 1 to June 30	do		With American Expeditionary Force in France and Germany.
	July	Regiment less 1st Battalion	1-20	Engers, Germany.
			21-23	En route to Brest, France.
			24-31	Camp Pontanezan, Brest, France.
		1st Battalion	1-18	Engers, Germany.
			19-22	En route to Brest, France.
			23-24	Camp Pontanezan, Brest, France.
			25-31	Aboard U. S. S. *Finland* en route to United States.
	August	Regiment less 1st Battalion	1- 8	Aboard U. S. S. *Great Northern* en route to Hoboken, N. J.
			9-11	Camp Mills, Long Island, N. Y.
			12-14	En route to Camp Travis, Tex.
			15-31	Camp Travis, Tex.
		1st Battalion	1- 5	Aboard U. S. S. *Finland* en route to Hoboken, N. J.
			6-10	Camp Mills, Long Island, N. Y.
			11-14	En route to Fort Riley, Kans.
			15-31	Fort Riley, Kans.
1920	Sept. 1 to Apr. 30	Regiment less 1st Battalion		Camp Travis, Tex.
		1st Battalion		Fort Riley, Kans.
	May	Regiment less 1st Battalion	1-31	Camp Travis, Tex.
		1st Battalion	1-26	Fort Riley, Kans.
			27-29	En route to Camp Travis, Tex.
			30-31	Camp Travis, Tex.
	June 1-Aug. 30	Regiment		Do.
	September	do	1- 3	Do.
			4-29	Camp Bullis, Tex.
			30	Camp Travis, Tex.
1921	Oct. 1 to Jan. 31	do		Do.

NOTE.—By authortiy contained in letter of Jan. 21, 1921, from Commanding General, 2d Division, Camp Travis, Tex., the 2d Engineers is ordered reorganized as per Table of Organization, Combat Engineer Regiment, table No. 63-W dated Dec. 13, 1920. The 2d Engineer Train was absorbed into the Regimental Headquarters and Supply Company 2d Engineers, Jan. 27, 1921. The records of the 2d Engineer Train forwarded to the Adjutant General on Feb. 7, 1921, by the Commanding Officer, 2d Engineers.

February	Regiment	1-28	Camp Travis, Tex.
March	Regiment less 1st Battalion	1-31	Do.
	1st Battalion	1-31	Camp Bullis, Tex.
April	Headquarters and Hq. & Sup. Company F.	1-30	Camp Travis, Tex.
	1st Battalion	1-15	Camp Bullis, Tex.
		16-30	Camp Travis, Tex.
	2d Battalion	1-15	Do.
		16-30	Camp Bullis, Tex.
May	Regiment less 2d Battalion	1-31	Camp Travis, Tex.
	2d Battalion	1-17	Camp Bullis, Tex.
		18-31	Camp Travis, Tex.
June	Regiment	1-15	Do.
		16-30	Camp Bullis, Tex. (target practice).
July	do	1-19	Camp Bullis, Tex.
		20-31	Camp Travis, Tex.
August	do	1-31	Do.
September	Regiment less Company F	1-30	Do.
	Company F	1-27	Do.
		28-30	Camp Bullis, Tex.
October	Regiment less Company F	1-31	Camp Travis, Tex.
	Company F	1- 7	Camp Bullis, Tex.
		8-31	Camp Travis, Tex.

Year	Month	Element	Dates	Station
1921	November	Regiment	1- 2	Camp Travis, Tex.
			3-22	Camp Bullis, Tex. (su tary target practice).
			23-30	Camp Travis, Tex.
1922	Dec. 1 to Feb. 28	do		Do.
	March	do	1-19	Do.
			20-31	Camp Bullis, Tex. (rifle pr
	April	do	1-30	Do.
	May	do	1- 5	Camp Bullis, Tex.
			6-30	Camp Travis, Tex.
	June 1 to Aug. 31	do	1-30	Do.
	September	Regiment less Company E	1-30	Do.
		Company E	1-17	Do.
			18-30	Fort Sam Hoston, Tex.
	October	Regiment less Companies B and E.	1-29	Camp Travis, Tex.
			29-31	Camp Bullis, Tex.
		Company B	1-31	Camp Travis, Tex.
		Company E	1-31	Fort Sam Houston, Tex.
	November	Regiment less Company E	1-24	Camp Bullis, Tex.
			25-30	Camp Travis, Tex.
		Company E	1-30	Fort Sam Houston, Tex.
1923	Dec. 1 to Feb. 28	Regiment less Company E		Camp Travis, Tex.
		Company E		Fort Sam Houston, Tex.
	March	Regiment less Company E	1-12	Do.
			13-31	Camp Bullis, Tex.
		Company E	1-31	Fort Sam Houston, Tex.
	April	Regiment less Company E	1-30	Camp Bullis, Tex.
		Company E	1-30	Fort Sam Houston, Tex.
	May	Regiment less Company E	1- 4	Camp Bullis, Tex.
			5-31	Fort Sam Houston, Tex.
		Company E	1-31	Do.
	June	Regiment	1-30	Do.
	July	Regiment less Company C	1-31	Do.
		Company C	1-12	Do.
			13-31	Camp Mabry, Austin, Tex.
	August	Regiment less Company C	1-31	Fort Sam Houston, Tex.
		Company C	1-17	Camp Mabry, Austin, Tex.
			18-31	Fort Sam Houston, Tex.
	Spetember	Regiment	1-30	Do.
	October	Regiment less Company E	1-14	Do.
			15-26	Camp Bullis and Camp Stanley, Tex.
		Regiment less Companies E, B, and C.	26-31	Fort Sam Houston, Tex.
		Companies B and C	26-31	Camp Bullis, Tex.
		Company E	1-31	Fort Sam Houston, Tex.
	November	Regiment less Companies B and C.	1-30	Do.
		Companies B and C	1-25	Camp Bullis, Tex.
			26-30	Fort Sam Houston, Tex.
1924	Dec. 1 to Apr. 30	Regiment		Do.
	May	Regiment less Company E	1-14	Do.
		Hq. & Sup. Company, Companies B and C.	15-27	Camp Bullis, Tex.
		Company A	15-31	Do.
		Companies D and F	16-27	Do.
		Regiment less Companies A and E.	28-31	Fort Sam Houston, Tex.
		Company E	1-31	Do.
	June	Regiment less Companies A and B.	1-30	Do.
		Company A	1-30	Sub-Post Camp Bullis, Tex.
		Company B (less 1 platoon)	1-21	Fort Sam Houston, Tex.
			21-30	Fort Crockett, Tex.
	July	Regiment less Companies A and B.	1-31	Fort Sam Houston, Tex.
		Company A	1-15	Sub-Post Camp Bullis, Tex.
			16-31	Fort Sam Houston, Tex.
		Company B (less 1 platoon)	1-21	Fort Crockett, Tex.
			22-31	Fort Sam Houston, Tex.
1925	Aug. 1 to Apr. 30	Regiment		Do.
	May	Regiment less Company E	1- 3	Do.
			4-16	Practice march.
			17-31	Fort Sam Houston, Tex.
		Company E	1-31	Do.
	June 1 to July 31	Regiment		Do.

	Month	Element	Dates	Station
	August	Regiment less Companies D and E.	1- 3	Fort Sam Houston, Tex.
			4-31	Camp Bullis, Tex.
		Companies D and E	1-31	Fort Sam Houston, Tex.
	September	Regiment less Companies B, D, and E.	1- 9	Camp Bullis, Tex.
			10-30	Fort Sam Houston, Tex.
		Company B	1- 9	Camp Bullis, Tex.
			10-30	Camp Stanley, Tex.
		Company D	1- 9	Fort Sam Houston, Tex.
			10-30	Camp Bullis, Tex.
		Company E	1-30	Fort Sam Houston, Tex.
	October	Regiment less Companies B and D.	1-31	Do.
		Company B	1-31	Camp Stanley, Tex.
		Company D	1-13	Camp Bullis, Tex.
			14-31	Fort Sam Houston, Tex.
	November	Regiment less Company B	1-30	Do.
		Company B	1-11	Camp Stanley, Tex.
			12-30	Fort Sam Houston, Tex.
1926	Dec. 1 to Feb. 28	Regiment		Do.
	March	Regiment less Company A	1-31	Do.
		Company A	1- 6	Do.
			7-31	Camp Bullis, Tex.
	April	Regiment	1-30	Fort Sam Houston, Tex.
	May	Regiment less Companies A and E.	1-11	Do.
			12-29	Practice march.
			30-31	Fort Sam Houston, Tex.
		Companies A and E	1-31	Do.
	June	Regiment less 1st Battalion	1-30	Do.
		1st Battalion	1- 6	Do.
			7-30	Camp Stanley, Tex.
	July	Regiment less 1st Battalion	1-31	Fort Sam Houston, Tex.
		1st Battalion	1- 9	Camp Stanley, Tex.
			10-25	Fort Sam Houston, Tex.
			26-31	Camp Stanley, Tex.
	August	Regiment less Companies A, B, and C.	1-17	Fort Sam Houston, Tex.
			18-31	Camp Bullis, Tex.
		Companies A, B, and C	1-17	Camp Stanley, Tex.
			18-31	Camp Bullis, Tex.
	September	Regiment less Company E	1-17	Do.
			18-28	Fort Sam Houston, Tex.
			29-30	Camp Stanley, Tex.
		Company E	1-30	Fort Sam Houston, Tex.
	October	Regiment less Company E	1-25	Camp Stanley, Tex.
			25-31	Fort Sam Houston, Tex.
		Company E	1-31	Do.
1927	Nov. 1 to Apr. 30	Regiment		Do.
	May	do	1	Do.
			2-23	Maneuvers, Camp Stanley and Camp Bullis, Tex.
			24-31	Construction, Camp Stanley and Camp Bullis, Tex.
	June	do	1-14	Fort Sam Houston, Tex.
		1st Battalion and detachment of Hq. & Serv. Company.	15-17	En route to Fort Logan, Colo.
			18-30	Fort Logan, Colo.
		2d Battalion and detachment of Hq. & Serv. Company.	15-17	En route to Fort Sam Houston, Tex.
			18-20	En route to Fort Logan, Colo.
			21-30	Fort Logan, Colo.
		NOTE.—The Hq. & Serv. Company moved to Fort Logan in two groups.		
	July	Regiment	1-31	Do.
	August	Regiment less 2d Battalion	1-31	Do.
		2d Battalion	1- 2	Do.
			2-26	Parker, Colo.
			27-31	Fort Logan, Colo.
	September	Regiment less 1st Battalion and Hq. & Serv. Company.	1-30	Do.
		1st Battalion and Hq. & Serv. Company.	1-24	Golden, Colo.
			25-30	Fort Logan, Colo.
1928	Oct. 1 to July 31	Regiment		Do.
	August	Regiment less 1st Battalion	1-31	Do.
		1st Battalion	1-14	Do.
			15-31	Golden, Colo.

Year	Month	Element	Dates	Station
1928	September	Regiment less Band	1-22	Golden, Colo.
			23-30	Fort Logan, Colo.
		Band	1-30	Do.
1929	Oct. 1 to June 30	Regiment		Do.
	July	Regiment less Hq. & Serv. Company.	1-31	Do.
		Hq. & Serv. Company	1-28	Do.
			29-31	Golden, Colo.
	August	Regiment less Hq. & Serv. Company and Band.	1-18	Fort Logan, Colo.
			19-31	Golden, Colo.
		Hq. & Serv. Company	1-17	Do.
			18-31	Fort Logan, Colo.
		Band	1-31	Do.
	September	Regiment less Hq. & Serv. Company and Band.	1-21	Golden, Colo.
			22-31	Fort Logan, Colo.
		Hq. & Serv. Company and Band.	1-31	Do.
	October	Regiment	1-31	Do.
		Company E	31	Placed on inactive list.
1930	Nov. 1 to Apr. 30	Regiment less Company E		Fort Logan, Colo.
		Company E		Inactive.
	May	Regiment less Hq. & Serv. Company and Company E.	1-11	Fort Logan, Colo.
			12-22	Practice march.
			23-31	Fort Logan, Colo.
		Hq. & Serv. Company	1-31	Fort Logan, Colo.
		Company E		Inactive.
	June	Regiment less Company E	1-30	Fort Logan, Colo.
		Company E		Inactive.
	July	Regiment less Hq. & Serv. Company and Companies C and E.	1-31	Fort Logan, Colo.
		Hq. & Serv. Company and Company C.	1-19	Do.
			20-31	Golden, Colo.
		Company E		Inactive.
	August	Regiment less Hq. & Serv. Company and Companies C and E.	1-16	Fort Logan, Colo.
			17-31	Golden, Colo.
		Hq. & Serv. Company and Company C.	1-16	Do.
			17-31	Fort Logan, Colo.
		Company E		Inactive.
	September	Regiment less Hq. & Serv. Company and Companies C and E.	1-12	Golden, Colo.
		Hq. & Serv. Company and Company C.	1-30	Fort Logan, Colo.
		Company E		Inactive.
	October	Regiment less Company E	1-31	Fort Logan, Colo.
		Company E		Inactive.
	November	Regiment less Company E	1-30	Fort Logan, Colo.
		Company B	30	Placed on inactive list.
		Company E		Inactive.
1931	Dec. 1 to May 31	Regiment less Companies B and E.		Fort Logan, Colo.
		Companies B and E		Inactive.
	June	Regiment less 2d Battalion, Company B and Hq. & Serv. Company.	1-30	Fort Logan, Colo.
		2d Battalion (less Company E) and Hq. & Serv. Company.	1-20	Do.
			21-30	Golden, Colo.
		Companies B and E		Inactive.
	July	Regiment less 2d Battalion, Company B and Hq. & Serv. Company.	1-31	Fort Logan, Colo.
		2d Battalion (less Company E) and Hq. & Serv. Company.	1-31	Golden, Colo.
		Companies B and E		Inactive.
	August	Regiment less Companies B, E, and Band.	1- 7	Fort Logan, Colo.
			8-21	Maneuvers (Pole Mountain) Fort Francis E. Warren, Wyo.
			22-31	Fort Logan, Colo.
		Band	1-31	Do.
		Companies B and E		Inactive.

Year	Month	Element	Dates	Station
1931	September	Regiment less Companies A, B, C, and E.	1-30	Fort Logan, Colo.
		Companies A and C	1-30	Golden, Colo.
		Companies B and E		Inactive.
	October	Regiment less Companies A, B, C, and E.	1-31	Fort Logan, Colo.
		Companies A and C	1- 8 9-31	Golden, Colo. Fort Logan, Colo.
		Companies B and E		Inactive.
	Nov. 1 to	Regiment less Companies B and E.		Fort Logan, Colo.
1932	July 31	Companies B and E		Inactive.
	August	Regiment less Hq. & Serv. Company, Companies A, B, C, E, and Band.	1-11 12-27 28-31	Fort Logan, Colo. Maneuvers, Fort Francis E. Warren, Wyo. Fort Logan, Colo.
		Hq. & Serv. Company and Companies A and C.	1- 6 7-11 12-27 28-31	Golden, Colo. Fort Logan, Colo. Maneuvers, Fort Francis E. Warren, Wyo. Fort Logan, Colo.
		Band	1-31	Do.
		Companies B and E		Inactive.
	September	Regiment less Companies B, D, E, and F.	1-30	Fort Logan, Colo.
		Companies D and F	1-23 24-30	Golden, Colo. Fort Logan, Colo.
		Companies B and E		Inactive.
	Oct. 1 to	Regiment less Companies B and E.		Fort Logan, Colo.
1933	June 30	Companies B and E		Inactive.
	July	Regiment less Companies B and E.	1-31	Fort Logan, Colo.
		Companies B [9] and E		Inactive.
		Headquarters 2d Battalion and Companies D and F.	31	Rendered inactive.
	August	Regiment less 2d Battalion	1-31	Fort Logan, Colo.
		2d Battalion		Inactive.
	Sept. 1 to	Regiment less 2d Battalion		Fort Logan, Colo.
1934	June 30	2d Battalion		Inactive.
	July	Regiment less 2d Battalion and Companies A and C.	1-31	Fort Logan, Colo.
		Companies A and C	1- 9 10-28 29-31	Do. Fort Francis E. Warren, Wyo. Fort Logan, Colo.
		2d Battalion		Inactive.
	August	Regiment less 2d Battalion and Company B.	1-31	Fort Logan, Colo.
		Company B	1-14 15-31	Do. Fort Francis E. Warren, Wyo.
		2d Battalion		Inactive.
	Sept. 1 to	Regiment less 2d Battalion		Fort Logan, Colo.
1935	May 31	2d Battalion		Inactive.
	June	Regiment less 2d Battalion and Band.	1-13 14-28 29-30	Fort Logan, Colo. Practice march. Fort Logan, Colo.
		Band	1-30	Do.
		2d Battalion		Inactive.
	July	Regiment less 2d Battalion	1-31	Fort Logan, Colo.
		2d Battalion		Inactive.
	August	Regiment less 2d Battalion and Band.	1- 6 7-16 17-31	Fort Logan, Colo. Maneuvers, Pole Mountain, Wyo. Fort Francis E. Warren, Wyo.
		Band	1-31	Fort Logan, Colo.
		2d Battalion		Inactive.
	September	Regiment less 2d Battalion and Band.	1- 7 8-30	Fort Francis E. Warren, Wyo. Fort Logan, Colo.
		Band	1-30	Do.
		2d Battalion		Inactive.
	Oct. 1 to	Regiment less 2d Battalion		Fort Logan, Colo.
1936	May 31	2d Battalion		Inactive.
	June	Regiment less 2d Battalion	1- 3 4-24 25-30	Fort Logan, Colo. Practice march, Pike National Forest. Fort Logan, Colo.

[9] Company B reconstituted on active list Aug. 1, 1933.

Year	Month	Element	Dates	Station
1936	June	2d Battalion		Inactive.
	July	Regiment less 2d Battalion	1–31	Fort Logan, Colo.
		2d Battalion		Inactive.
	August	Regiment less 2d Battalion	1– 4	Fort Logan, Colo.
			5–13	Maneuvers, Pole Mountain, Wyo.
		Company A and Band	14–31	Fort Logan, Colo.
		Companies B, C, and Hq. & Serv. Co.	14–31	Fort Francis E. Warren, Wyo.
		2d Battalion		Inactive.
	September	Regiment less 2d Battalion, Company A and Band.	1	Fort Francis E. Warren, Wyo.
			2–30	Fort Logan, Colo.
		Company A and Band	1–30	Do.
		2d Battalion		Inactive.
	Oct. 1 to Dec. 31	Regiment less 2d Battalion		Fort Logan, Colo.
		2d Battalion		Inactive.
1937	Jan. 1 to May 31	Regiment less 2d Battalion		Fort Logan, Colo.
		2d Battalion		Inactive.
	June	Regiment less 2d Battalion	1– 2	Fort Logan, Colo.
			3–17	Practice march to Pike National Forest.
		2d Battalion		Inactive.
	July 1 to Aug. 31	Regiment less 2d Battalion		Fort Logan, Colo.
		2d Battalion		Inactive.
	September	Regiment less Band, Companies A and B and 2d Battalion.	1– 2	Fort Logan, Colo.
			3– 8	En route to Camp Bullis, Tex.
			9–30	Participation in test of proposed infantry division in vicinity of Fort Sam Houston, Tex.
		Band and Companies A and B	1–30	Fort Logan, Colo.
		2d Battalion		Inactive.
	October	Regiment less Band, Companies A and B and 2d Battalion.	1–31	Participation in tests of proposed infantry division in vicinity of Fort Sam Houston, Tex.
		Band, Companies A and B	1–31	Fort Logan, Colo.
		2d Battalion		Inactive.
	November	Regiment less Band, Companies A and B and 2d Battalion.	1– 3	Camp Bullis, Tex.
			4–11	En route to Fort Logan, Colo.
			12–30	Fort Logan, Colo.
		Band, Companies A and B	1–30	Do.
		2d Battalion		Inactive.
	December	Regiment less 2d Battalion	1–31	Fort Logan, Colo.
		2d Battalion		Inactive.

SECOND ENGINEER TRAIN

The Second Engineer Train, Infantry, was organized April 23, 1917, under the provisions of the Act of Congress approved June 3, 1916, by R. S. O. 88 Second Engineers, dated April 23, 1917, per instructions from C. G. Second Prov. Infantry Division and Department Adjutant, Southern Department, and pursuant to letter A. G. 2416322–A dated March 21, 1917. Attached to Second Engineers for organization per instructions from C. G. Southern Department. Designation changed to Second Engineer Train per G. O. No. 88, Headquarters Southern Department, dated July 29, 1917, pursuant to instructions of the War Department dated July 10, 1917.

Year	Month	Element	Dates	Station
1917	April	2d Engineer Train	23–30	Courchesne Bridge, El Paso, Tex.
	May 1 to July 31	do		Do.
	August	do	1–21	Do.
			22–28	En route to Washington, D. C.
			29–31	Camp American University, Washington, D. C.
	September	do	1	En route to Newport News, Va.
			2–30	Newport News, Va.
	October	do	1–20	Do.
			21–31	Aboard *Panaman* en route to St. Nazaire, France.
	November	do	1–12	Do.
			13–30	With American Expeditionary Forces in France.
1919	Dec. 1 to June 30	do		With American Expeditionary Forces in France and Germany.
	July	do	1–19	Block Heimbach, Germany.
			20	Marched to Engers, Germany, and entrained for Brest, France.
			21–23	En route to Brest, France.
			24–26	Camp Pontanezen, Brest, France.
			27	Marched to Pier 5, Brest and boarded U. S. S. *Wilhelmina*.
			28–31	Enroute to United States.
	August	do	1–5	Aboard U. S. S. *Wilhelmina* en route to Hoboken, N. J.
			6	En route by marching to Camp Merritt, N. J.
			7–10	Camp Merritt, N. J.
			11–16	En route to Camp Travis, Tex.
			17–31	Camp Travis, Tex.
1920	Sept. 1 to Dec. 31	do		Do.
1921	January	do	1–26	Do.
			27	Absorbed into the Regimental Headquarters and Service Company, 2d Engineers.

THIRD ENGINEERS

In accordance with the provisions of the Act of Congress approved June 3, 1916, and pursuant to G. O. No. 22, War Department, 1916, the Third Regiment of Engineers was organized in the following manner: (1) Headquarters, Third Battalion of Engineers stationed at Fort Santiago, Manila, P. I., redesignated Regimental Headquarters, Third Regiment of Engineers, August 1, 1916; (2) Headquarters, First Battalion, Third Regiment of Engineers organized at Fort Santiago, Manila, P. I., August 1, 1916, from Headquarters Third Battalion of Engineers; (3) Company K, Third Battalion of Engineers stationed at Fort Mills, P. I., redesignated Company A, Third Regiment of Engineers August 1, 1916; (4) Company L, Third Battalion of Engineers stationed at Fort William McKinley, P. I., redesignated Company B, Third Regiment of Engineers, August 1, 1916; (5) Company I, Third Battalion of Engineers stationed at Fort Shafter, T. H. redesignated Company C, Third Regiment of Engineers August 15, 1916; (6) Headquarters, Second Battalion, Third Regiment of Engineers, organized July 27, 1916, at Corozal, Canal Zone, by transfers from Company M, Third Battalion of Engineers; (7) Company D, Third Regiment of Engineers formed at Fort Shafter, T. H., August 15, 1916, by transfers from Companies I, K, and L, Third Battalion of Engineers; (8) Company M, Third Battalion of Engineers stationed at Corozal, Canal Zone, redesignated Company E, Third Regiment of Engineers, July 27, 1916; (9) Company F, Third Regiment of Engineers formed by transfer of 2 officers and 72 enlisted men from Company M, Third Battalion of Engineers, July 27, 1916.

Year	Month	Element	Dates	Station
1916	July	2d Battalion less Company D	27-31	Corozal, Canal Zone.
	Aug. 1 to Sept. 30	Regimental headquarters and headquarters 1st Battalion.		Fort Santiago, Manila, P. I.
		Company A		Fort Mills, P. I.
		Company B		Fort William McKinley, P. I.
		Companies C and D (Aug. 15 to Sept. 30).		Fort Shafter, T. H.
		2d Battalion less Company D		Corozal, Canal Zone.
	October	Regimental headquarters and headquarters 1st Battalion.	1-31	Fort Santiago, Manila, P. I.
		Company A	1-31	Fort Mills, P. I.
		Company B	1-31	Fort William McKinley, P. I.
		Companies C and D	1-31	Fort Shafter, T. H.
		Headquarters 2d Battalion and Company E.	1-31	Camp Gaillard, Canal Zone.
		Company F	1-31	Culebra, Canal Zone.
	Nov. 1 to Sept. 30	Regimental headquarters and headquarters 1st Battalion.		Fort Santiago, Manila, P. I.
		Company A		Fort Mills, P. I.
1917		Company B		Fort William McKinley, P. I.
		Companies C and D		Fort Shafter, T. H.
		2d Battalion less Company D		Corozal, Canal Zone.
	October	Regimental headquarters	1-14	Fort Santiago, Manila, P. I.
			15-31	Aboard U. S. Army transport *Sheridan* en route to Honolulu.
		Headquarters 1st Battalion	1-31	Fort Santiago, Manila, P. I.
		Company A	1-31	Fort Mills, P. I.
		Company B	1-31	Fort William McKinley, P. I.
		Companies C and D	1-31	Fort Shafter, T. H.
		2d Battalion less Company D	1-31	Corozal, Canal Zone.

Year	Month	Element	Dates	Station
1917	November	Regimental headquarters	1- 6	En route to Honolulu, T. H.
			7-30	Fort Shafter, T. H.
		Headquarters 1st Battalion	1-30	Fort Santiago, Manila, P. I.
		Company A	1-30	Fort Mills, P. I.
		Company B	1-30	Fort William McKinley, P. I.
		Companies C and D	1-30	Fort Shafter, T. H.
		2d Battalion less Company D	1-30	Corozal, Canal Zone.
	December	Regimental headquarters and Companies C and D.	1-31	Fort Shafter, T. H.
		Company A	1-31	Fort Mills, P. I.
		Company B	1-31	Fort William McKinley, P. I.
		2d Battalion less Company D	1-31	Corozal, Canal Zone.
1918	January	Regimental headquarters, Companies C and D.	1- 9	Fort Shafter, T. H.
			10-31	Schofield Barracks, T. H.
		Headquarters 1st Battalion	1-31	Fort Santiago, Manila, P. I.
		Company A	1-31	Fort Mills, P. I.
		Company B	1-31	Fort William McKinley, P. I.
		2d Battalion less Company D	1-31	Corozal, Canal Zone.
	Feb. 1 to May 31	Regimental headquarters, Companies C and D.		Schofield Barracks, T. H.
		Headquarters 1st Battalion		Fort Santiago, Manila, P. I.
		Company A		Fort Mills, P. I.
		Company B		Fort William McKinley, P. I.
		2d Battalion less Company D		Corozal, Canal Zone.
	June	Regimental headquarters, Companies C and D.	1-30	Schofield Barracks, T. H.
		Headquarters 1st Battalion	1-30	Fort Santiago, Manila, P. I.
		Company A	1-30	Fort Mills, P. I.
		Company B	1-30	Ft. William McKinley, P. I.
		2d Battalion less Company D	1-27	Corozal, Canal Zone.
			28-30	Panama City (police duty).
	July 1 to Aug. 31	Regimental Headquarters, Companies C and D.		Schofield Barracks, T. H.
		Headquarters, 1st Battalion		Fort Santiago, Manila, P. I.
		Company A		Fort Mills, P. I.
		Company B		Fort William McKinley, P. I.
		2nd Battalion less Company D		Corozal, Canal Zone.

NOTE.—A detachment of 18 enlisted men from the 1st Battalion, Manila, P. I., under command of Capt. Earle W. Jennings, Engineer, U. S Army, left Manila, P. I., on Aug. 7, 1918, for extended field service with the 27th Infantry at Vladivostok, Siberia. Arrived at Vladivostok on Aug. 16, 1918. Entire personnel of detachment engaged in reconnaissance and reproduction work in and around Vladivostok, Siberia.

	September	Regimental Headquarters, Companies C and D.	1-30	Schofield Barracks, T. H.
		Headquarters, 1st Battalion	1-30	Fort Santiago, Manila, P. I.
		Company A	1-30	Fort Mills, P. I.
		Company B	1-15	Fort William McKinley, P. I.
			16-30	Marching to and at Camp Nichols, Rizal, P. I.
		2d Battalion less Company D	1-30	Corozal, Canal Zone.
	October	Regimental Headquarters, Companies C and D.	1-31	Schofield Barracks, T. H.
		Headquarter, 1st Battalion	1-31	Fort Santiago, Manila, P. I.
		Company A	1-31	Fort Mills, P. I.
		Company B	1-31	Camp Nichols, Rizal, P. I.
		2d Battalion less Company D	1-31	Corozal, Canal Zone.
	November	Regimental Headquarters, Companies C and D.	1-30	Schofield Barracks, T. H.
		Headquarters, 1st Battalion	1-30	Fort Santiago, Manila, P. I.
		Company A	1-30	Fort Mills, P. I.
		Company B	1-29	Camp Nichols, Rizal, P. I.
			30	Fort William McKinley, P. I.
		2d Battalion less Company D	1-30	Corozal, Can al Zone.
1919	Dec. 1 to Jan. 31	Regimental Headquarters, Companies C and D.		Schofield Barracks, T. H.
		Headquarters, 1st Battalion		Fort Santiago, Manila, P. I.
		Company A		Fort Mills, P. I.
		Company B		Fort William McKinley, P. I.
		2d Battalion less Company D		Corozal, Canal Zone.
	February	Regimental Headquarters, Companies C and D.	1-28	Schofield Barracks, T. H.
		Headquarters, 1st Battalion	1-28	Fort Santiago, Manila, P. I.
		Company A	1-28	Fort Mills, P. I.
		Company B	1-16	Fort William McKinley, P. I.
			17-28	Camp Tomas Claudio, P. I.
		2d Battalion less Company D	1-28	Corozal, Canal Zone.
1920	Mar. 1 to Mar. 31	Regimental Headquarters, Companies C and D.		Schofield Barracks, T. H.
		Headquarters, 1st Battalion		Fort Santiago, Manila, P. I.
		Company A		Fort Mills, P. I.
		Company B		Fort William McKinley, P. I.
		2d Battalion less Company D		Corozal, Canal Zone.

Year	Month	Element	Dates	Station
1920	Apr. 1 to Oct. 31	Regimental Headquarters, Headquarters Detachment, Band, Companies C and D.		Schofield Barracks, T. H.
		Headquarters, 1st Battalion		Fort Santiago, Manila, P. I.
		Company A		Fort Mills, P. I.
		Company B		Fort William McKinley, P. I.
		2d Battalion less Company D		Corozal, Canal Zone.
	November	Regimental Headquarters, Headquarter Detachment, Band, Companies C and D.	1-30	Schofield Barracks, T. H.
		Headquarters, 1st Battalion	1-30	Manila, P. I.
		Company A	1-30	Fort Mills, P. I.
		Company B	1-30	Fort William McKinley, P. I.
		2d Battalion less Company D	1-16	Corozal, Canal Zone.
			17-30	Schofield Barracks, T. H.

NOTE.—Pursuant to letter from the Adjutant General of the Army under date of Nov. 4, 1920, the equipment and personnel of Headquarters 2d Battalion and Companies E and F were, on Nov. 16, 1920, transferred to the 11th Engineers and the station of Headquarters 2d Battalion and Companies E and F was at Schofield Barracks, T. H., for the remainder of the month.

Year	Month	Element	Dates	Station
1921	Dec. 1 to Feb. 28	Regiment less 1st Battalion Headquarters and Companies A and B.		Schofield Barracks, T. H.
		Headquarters, 1st Battalion		Manila, P. I.
		Company A		Fort Mills, P. I.
		Company B		Fort William McKinley, P. I.
	March	Regiment less 1st Battalion Headquarters and Companies A and B.	1-31	Schofield Barracks, T. H.
		Headquarters, 1st Battalion	1-15	Manila, P. I.
			16-31	En route to join Regiment at Schofield Barracks, T. H.
		Company A	1-15	Fort Mills, P. I.
			16-31	En route to join Regiment at Schofield Barracks, T. H.
		Company B	1-15	Fort William McKinley, P. I.
			16-31	En route to join Regiment at Schofield Barracks, T. H.
	April	Regiment less 1st Battalion Headquarters and Companies A and B.	1-14	Schofield Barracks, T. H.
		Headquarters 1st Battalion, Companies A and B.	1-14	En route from Philippines to join Regiment.
		Regiment	15-30	Schofield Barracks, T. H.
	May 1 to June 30	do		Do.
	July	Regiment less Company C	1-31	Do.
		Company C	1-21	Do.
			22-31	Puuiki, Island of Oahu.
	August	Regiment less Companies B and C.	1-31	Schofield Barracks, T. H.
		Company B	1-19	Do.
			20-31	Waianae, Island of Oahu.
		Company C	1-29	Puuiki, Island of Oahu.
			30-31	Schofield Barracks, T. H.
	September	Regiment less Companies B and E.	1-30	Do.
		Company B	1- 2	Wainae, Island of Oahu.
			3-30	Schofield Barracks, T. H.
		Company E	1- 2	Do.
			3-14	Wainae, Island of Oahu.
			15-30	Schofield Barracks, T. H.
1922	Oct. 1 to Mar. 31	Regiment		Do.
	April	Regiment less Company B	1-30	Do.
		Company B	1- 7	Do.
			8-30	Pupukea, Island of Oahu.
	May 1 to June 30	Regiment		Schofield Barracks, T. H.
	July	Regiment less Company D	1-31	Do.
		Company D	1-31	Pupukea, Island of Oahu.
	August	Regiment less Companies D and F.	1-31	Schofield Barracks, T. H.
		Company D	1- 7	Pupukea Heights, Island of Oahu.
			8-31	Schofield Barracks, T. H.
		Company F	1- 7	Do.
			8-31	Pupukea Heights, Island of Oahu.
	September	Regiment less Companies C and F.	1-30	Schofield Barracks, T. H.
		Company C	1-21	Do.
			22-30	Pupukea Heights, Island of Oahu.
		Company F	1-21	Do.
			22-30	Schofield Barracks, T. H.

Year	Month	Element	Dates	Station
1922	Oct. 1 to Nov. 30	Regiment less Company C		Schofield Barracks, T. H.
		Company C		Waimea Canyon, Island of Oahu.
1926	Dec. 1 to Mar. 31	Regiment		Schofield Barracks, T. H.
	April	Regiment less Company E	1–30	Do.
		Company E	1–21	Do.
			22–30	Camp at Kawaihapai, Military Reservation.
	May	Regiment less Companies A, C, D, E, F, and Band.	1–31	Schofield Barracks, T. H.
		Companies A, C, D, F, and Band	1–27	Do.
			28–31	Fort Armstrong, T. H.
		Company E	1– 7	Camp at Kawaihapai Military Reservation.
			8–27	Schofield Barracks, T. H.
			28–31	Fort Armstrong, T. H.
	June	Regiment less Companies A, C, D, E, F, and Band.	1–30	Schofield Barracks, T. H.
		Companies A, C, D, E, F	1–30	Fort Armstrong, T. H.
		Band	1–15	Do.
			16–30	Schofield Barracks, T. H.
	July	Regiment less Companies A, C, D, E, F.	1–31	Do.
		Companies A and C	1–31	Fort Armstrong, T. H.
		Companies D, E, F	1–15	Do.
			16–31	Schofield Barracks, T. H.
	August	Regiment less Companies A and C.	1–31	Do.
		Companys A and C	1–14	Fort Armstrong, T. H.
			15–31	Schofield Barracks, T. H.
1927	Sept 1 to June 30	Regiment		Do.
	July	Regiment less Companies B, E, F, and Hq. & Serv. Company.	1– 4	Do.
			5–27	Rest Camp, Puena Point.
			28–31	Schofield Barracks, T. H.
		Companies B, E, F, and Hq. & Serv. Company.	1–31	Do.
	August	Regiment[10]	1–31	Do.
	Sept. 1 to Oct. 31	do.[11]		Do.
1928	Nov. 1 to Jan. 31	do.		Do.
	February	Regiment less Company C	1–29	Do.
		Company C	1–13	Do.
			14–29	Fort Kamehameha, T. H.
	March	Regiment less Company C	1–31	Schofield Barracks, T. H.
		Company C	1–31	Fort Kamehameha, T. H.
	April	Regiment less Company C	1–30	Schofield Barracks, T. H.
		Company C	1–16	Fort Kamehameha, T. H.
			17–30	Schofield Barracks, T. H.
1929	May 1 to May 31	Regiment		Do.
	June	Regiment less Companies A, B, C.	1–30	Do.
		Company A	1– 8	Do.
			9–22	Ewa Sector (maneuvers).
			23–30	Schofield Barracks, T. H.
		Company B	1– 8	Do.
			9–22	Haleiwa Sector (maneuvers).
			23–30	Schofield Barracks, T. H.
		Company C	1– 5	Do.
			6–22	Punchbowl, Honolulu, T. H.
			23–30	Schofield Barracks, T. H.
	July	Regiment less Companies D, E, F.	1–31	Do.
		Companies D, E, and F	1– 7	Do.
			8–30	Practice march to Fort Ruger and return.
			31	Schofield Barracks, T. H.
	August	Regiment less Companies A, B, C, and Hq. & Serv. Company.	1–31	Do.
		Companies A, B, C	1– 5	Do.
			6–17	En route to Puuiki, T. H. (marching).
			18–30	Puuiki, T. H.
			31	Schofield Barracks, T. H.

[10] Band was organized as separate element Aug. 1, 1927.
[11] 1st and 2d Battalion Headquarters were organized in accordance with T. O. 64 P on October 18, 1927.

Year	Month	Element	Dates	Station
1933	February	Company C	1- 8	Fort Kamehameha, T. H.
			9-28	Schofield Barracks, T. H.
		Band		Inactive.
	Mar. 1 to July 31	Regiment less Band		Schofield Barracks, T. H.
		Band		Inactive.
	August	Regiment less 2d Battalion and Band.	1-31	Schofield Barracks, T. H.
		2d Battalion	1-28	Do.
			29-31	Fort Weaver, T. H.
		Band		Inactive.
	September	Regiment less 1st and 2d Battalion and Band.	1-30	Schofield Barracks, T. H.
		1st Battalion	1-11	Do.
			12-18	Kawailoa, T. H.
			19-30	Schofield Barracks, T. H.
		2d Battalion	1- 8	Fort Weaver, T. H.;
			9-30	Schofield Barracks, T. H.
		Band		Inactive.
	Oct. 1 to Nov. 30	Regiment less Band		Schofield Barracks, T. H.
		Band		Inactive.
	December	Regiment less Cos. A, B, C, and Band.	1-31	Schofield Barracks, T. H.
		Company A	1-11	Do.
			12-13	Mokuleia, T. H.
			14-31	Schofield Barracks, T. H.
		Company B	1-13	Do.
			14-18	Mokuleia, T. H.
			19-31	Schofield Barracks, T. H.
		Company C	1-18	Do.
			19-20	Mokuleia, T. H.
			21-31	Schofield Barracks, T. H.
		Band		Inactive.
1934	January	Regiment less Band	1-31	Schofield Barracks, T. H.
		Band		Inactive.
	February	Regiment less Cos. D, E, F, and Band.	1-28	Schofield Barracks, T. H.
		Company D	1- 6	Do.
			7- 8	Koolau Camp Site, T. H.
			9-28	Schofield Barracks, T. H.
		Company E	1- 8	Do.
			9	Koolau Camp Site, T. H.
			10-28	Schofield Barracks, T. H.
		Company F	1	Do.
			2- 6	Koolau Camp Site, T. H.
			7-28	Schofield Barracks, T. H.
		Band		Inactive.
	Mar. 1 to Apr. 30	Regiment less Band		Schofield Barracks, T. H.
		Band		Inactive.
	May	Regiment less Companies, B, C, D, and Band.	1-31	Schofield Barracks. T. H.
		Company B	1- 9	Do.
			10	Koolau Camp Site, T. H.
			11-21	Schofield Barracks, T. H.
			22-25	Makua, T. H.
			26-31	Schofield Barracks, T. H.
		Company C	1-21	Do.
			22-25	Camp Kawaihapaia.
			26-31	Schofield Barracks, T. H.
		Company D	1-21	Do.
			22-25	Makua, T. H.
			26-31	Schofield Barracks, T. H.
		Band		Inactive.
	June 1 to July 31	Regiment less Band		Schofield Barracks, T. H.
		Band		Inactive.
	August	Regiment less 1st Battalion and Band.	1-31	Schofield Barracks, T. H.
		1st Battalion	1-21	Do.
			22-31	Camp Kawailoa, T. H.
		Band		Inactive.
	September	Regiment less 1st and 2d Battalions and Band.	1-30	Schofield Barracks, T. H.
		1st Battalion	1- 3	Camp Kawailoa, T. H.
			4-30	Schofield Barracks, T. H.
		2d Battalion	1- 7	Do.
			8-17	Fort Weaver, T. H.
			18-30	Schofield Barracks, T. H.
		Band		Inactive.
	Oct. 1 to Sept. 30	Regiment less Band		Schofield Barracks, T. H.
1935		Band		Inactive.
	October	Regiment less Company D and Band.	1-31	Schofield Barracks, T. H.
		Company D	1- 5	Do.
			6-12	Island at Maui, T. H.
			13-31	Schofield Barracks, T. H.
		Band		Inactive.

Year	Month	Element	Dates	Station
1935	Nov. 1 to Jan. 31	Regiment less Band		Schofield Barracks, T. H.
1936		Band		Inactive.
	February	Regiment less Company A and Band.	1-29	Schofield Barracks, T. H.
		Company A	1-17	Do.
			18-29	Waianae Camp Site.
		Band		Inactive.
	March	Regiment less Band	1-31	Schofield Barracks, T. H.
		Band		Inactive.
	April	Regiment less Companies B and D and Band.	1-30	Schofield Barracks, T. H.
		Company B	1-20	Do.
			21-24	Kawailoa, T. H.
			25-30	Schofield Barracks, T. H.
		Company D	1-11	Do.
			12-14	Nanakuli, T. H.
			15-20	Schofield Barracks, T. H.
			21-22	Puulupe, T. H.
			23-30	Schofield Barracks, T. H.
		Band		Inactive.
	May	Regiment less Band	1-31	Schofield Barracks, T. H.
		Band		Inactive.
	June	Regiment less Hq. & Serv. Company and Band.	1- 5	Schofield Barracks, T. H.
			6-16	Maneuvers.
			17-30	Schofield Barracks, T. H.
		Hq. & Serv. Company	1-30	Do.
		Band		Inactive.
	July 1 to Nov. 30	Regiment less Band		Schofield Barracks, T. H.
		Band		Inactive.
	December	Regiment less Company A and Band.	1-31	Schofield Barracks, T. H.
		Company A	1-23	Waianae, T. H.
			24-31	Schofield Barracks, T. H.
		Band		Inactive.
1937	January	Regiment less Companies A and B and Band.	1-31	Schofield Barracks, T. H.
		Company A	1- 4	Do.
			5- 9	Waianae, T. H.
			10-31	Schofield Barracks, T. H.
		Company B	1-31	Kawaihapai, T. H.
		Band		Inactive.
	February	Regiment less Companies A, B, E, and Band.	1-28	Schofield Barracks, T. H.
		Company A	1-22	Do.
			23-28	Waianae, T. H.
		Company B	1-22	Schofield Barracks, T. H.
			23-28	Kawailoa, T. H.
		Company E	1- 3	Pau Manawahau Forest Reserve.
			4-28	Schofield Barracks, T. H.
		Band		Inactive.
	Mar. 1 to June 30	Regiment less Band		Schofield Barracks, T. H.
		Band		Inactive.
	July	Regiment less Companies A, D, E, and Band.	1-31	Schofield Barracks, T. H.
		Companies A, D, E	1-16	Waianae, T. H.
			17-31	Schofield Barracks, T. H.
		Band		Inactive.
	Aug. 1 to Sept. 30	Regiment less Band	1-31	Schofield Barracks, T. H.
		Band		Inactive.
	October	Regiment less Company B and Band.	1-31	Schofield Barracks, T. H.
		Company B	1-24	Do.
			25-31	Waimae Quarry, T. H.
		Band		Inactive.
	November	Regiment less Band	1	Schofield Barracks, T. H.
			2- 5	Kawailoa Camp, maneuvers.
			6-15	Schofield Barracks, T. H.
			16-24	Waianae, T. H.
			25-30	Schofield Barracks, T. H.
	December	Regiment less Band	1-31	Do.
		Band		Inactive.

FOURTH ENGINEERS

The organization of the Fourth United States Engineers under the provisions of the Act of Congress approved June 3, 1916, and pursuant to General Orders No. 62, War Department, May 14, 1917, was accomplished at Vancouver Barracks, Wash. Col. Edward Burr assumed command June 4, 1917, R. O. No. 1, same date. Companies E and F, Second Engineers, stationed at Vancouver Barracks, Wash., were redesignated Companies A and B, Fourth Engineers, respectively, June 6, 1917, by R. O. No. 2. Organization of regiment completed June 20, 1917.

Year	Month	Element	Dates	Station
1917	June	Regiment less Companies A and B.	4-30	Vancouver Barracks, Wash.
		Companies A and B	6-17	American Lake, Wash.
			18-30	Vancouver Barracks, Wash.
	July 1 to Nov. 30	Regiment		Do.
	December	do	1-21	Do.
			22-31	En route to Camp Greene, N. C.
1918	Jan. 1 to Mar. 31	do		Camp Greene, N. C.
	April	do	1-20	Do.
			21-22	En route to Camp Merritt, N. J.
			23-28	Camp Merritt, N. J.
			29	En route to port of embarkation, Hoboken, N. J.
1918	April	do	30	Aboard *Martha Washington* en route to Bordeaux, France.
	May	do	1-13	Do.
			14-31	With American Expeditionary Forces in France.
1919	June 1 to June 30	do		With American Expeditionary Forces in France and Germany.
	July	do	1-13	Coblenz, Germany.
			14-16	En route to Brest, France.
			17-20	Brest, France.
			21-29	En route to Hoboken, N. J., aboard U. S. S. *Von Steuben* (arrived Camp Merritt, N. J., same day).
			30-31	Camp Merritt, N. J.
	August	do	1- 3	En route to Camp Dodge, Iowa.
			4-31	Camp Dodge, Iowa.
1920	Sept 1 to July 31	do		Do.
	August	do	1-19	Do.
			20-24	En route to Camp Lewis, Wash.
			25-31	Camp Lewis, Wash.
1921	Sept 1 to Aug. 31	do		Do.
	September	Regiment [10]	1-21	Camp Lewis, Wash.
			22	Inactive.[11]
1922	July	Company A [12]	24-31	Camp Bragg, N. C.
		Regiment less Company A		Inactive.
	August	Company A	1-31	Camp Bragg, N. C.
		Regiment less Company A		Inactive.
1929	Sept. 1 to Sept. 30	Company A		Fort Bragg, N. C.
		Regiment less Company A [13]		Inactive.

[10] Engineer Training Company No. 9 was organized from the regiment, the personnel of 3 officers and 45 enlisted men being transferred thereto on Sept. 21, 1921.

[11] Regiment inactive from Sept. 23, 1921, to July 23, 1922 (both dates inclusive).

[12] Entire personnel of Company F, 13th Engineers, transferred to Company A, 4th Engineers, which was reconstituted on the active list and took station at Camp Bragg, N. C.

[13] Company A rendered inactive Sept. 20, 1929, at Fort Bragg, N. C.

Year	Month	Element	Dates	Station
1929 1933	Oct. 1 to Sept. 30	Regiment		Inactive.
	October	Company A [14]	1-31	Fort Benning, Ga.
	Nov. 1 to	Company A		Do.
1936	Dec. 31	Regiment less Company A		Inactive.
1937	Jan. 1 to Aug. 31	Company A		Fort Benning, Ga.
		Regiment less Company A		Inactive.
	September	Company A	1-26	Fort Benning, Ga.
			27-30	Practice march.
		Regiment less Company A		Inactive.
	October	Company A	1- 2	Practice march.
			3-31	Fort Benning, Ga.
		Regiment less Company A		Inactive.
	Nov. 1 to Dec. 31	Company A		Fort Benning, Ga.
		Regiment less Company A		Inactive.

---

[14] Company A, 4th Engineers, reconstituted on the active list at Fort Benning, Ga., on Oct. 1, 1933, and the personnel of Company A, 7th Engineers, was transferred thereto on that date.

FOURTH ENGINEER TRAIN

The Fourth Engineer Train was organized at Vancouver Barracks, Wash., on August 1, 1917, under the provisions of the Act of Congress approved May 18, 1917, and pursuant to first indorsement A. G. O., dated June 9, 1917, file 2605788.

Year	Month	Element	Dates	Station
1917	Aug. 1 to Nov. 30	4th Engineer Train	--------	Vancouver Barracks, Wash.
	December	do	1-21	Do.
			22-31	En route to Camp Greene, N. C.
1918	Jan. 1 to Mar. 31	do	--------	Camp Greene, N. C.
	April	do	1-20	Do.
			21-22	En route to Camp Merritt, N. J.
			23-28	Camp Merritt, N. J.
			29	En route to port of embarkation, Hoboken, N. J.
			30	Aboard *Martha Washington* en route to Bordeaux, France.
	May	do	1-13	Do.
			14-31	With American Expeditionary Forces in France.
1919	June 1 to June 30	do	--------	With American Expeditionary Forces in France and Germany.
	July	do	1-13	Coblenz, Germany.
			14-16	En route to Brest, France.
			17-20	Brest, France.
			21-29	Aboard U. S. S. *Von Steuben* en route to Hoboken, N. J. (Arrived Camp Merritt, N. J., same day.)
			30-31	Camp Merritt, N. J.
	August	do	1- 3	En route to Camp Dodge, Iowa.
			4-31	Camp Dodge, Iowa.
1920	Sept. 1 to July 31	do	--------	Do.
	August	do	1-19	Do.
			20-24	En route to Camp Lewis, Wash.
			25-31	Camp Lewis, Wash.
	Sept. 1 to Dec. 31	do	--------	Do.

NOTE.—In accordance with War Department Circular 400, 1920 and pursuant to General Order No. 3, Headquarters, 4th Division, Camp Lewis, Wash., dated Jan. 27, 1921, the 4th Engineer Train ceased to exist as a separate organization and was absorbed into the Headquarters and Service Company, 4th Engineers.

FOURTH BATTALION

(Consisting of Battalion Headquarters and Companies M, N, O, and P—Battalion Headquarters and Companies N, O, and P were not organized. Consideration was being given to the organization of Companies N, O, and P at Camp A. A. Humphreys, Va., but the signing of the Armistice precluded their actual organization.)

Year	Month	Element	Dates	Station
1918	November	Company M [51]	14–30	Toul, France.
	December	do	1–31	Do.
1919	January	do	1–20	Do.
			21	En route to Langres, France.
			22–31	Langres, France (attached to 1st Battalion).
	Feb. 1 to Apr. 30	do		Do.
	May	do	1– 7	Do.
			8	Transferred to 3d Army, Coblenz, Germany.
			9–31	Coblenz, Germany.
	June 1 to July 31	do		Do.
	August	do	1– 3	Do.
			4– 7	En route to Camp Pontanezen, Brest, France.
			8	Camp Pontanezen, Brest, France.
			9	Boarded U. S. S. *Troy*.
			10–20	Aboard U. S. S. *Troy* en route to Brooklyn, N. Y.
			21–24	On pier No. 3, Hoboken, N. J.
			25–26	En route to Camp A. A. Humphreys, Va.
			27–31	Camp A. A. Humphreys, Va.
	September	do	1– 2	Do.
				Demobilized Sept. 2.

[51] Company M (surveying and printing) was organized on Nov. 14, 1918, pursuant to sec. II, G. O. No. 182. G. H. Q., A. E. F., 1918, at Toul, Meruthe et Moselle, France, by transfers of surplus personnel from Headquarters, 1st Battalion, 29th Engineers per S. O. No. 338, G. H. Q., A. E. F., 1918.

Year	Month	Element	Dates	Station
1919	July	Regiment less Company E	1–31	Camp A. A. Humphreys, Va.
		Company E	1–31	D. S. with Transcontinental Motor Convoy.
	August	Regiment less Companies A, D, and E.	1–31	Camp A. A. Humphreys, Va.
		Companies A and D	1–19	Do.
			20	En route to Camp Mills, N. Y.
			21–31	Camp Mills, N. Y.
		Company E	1–31	D. S. with Transcontinental Motor Convoy.
	September	Regiment less Companies A, C, D, and E.	1–30	Camp A. A. Humphreys, Va.
		Companies A and D	1– 3	Camp Mills, N. Y.
			4	En route to Camp A. A. Humphreys, Va.
			5–30	Camp A. A. Humphreys, Va.
		Company C	1– 3	Do.
			4– 6	En route to Carlstrom Field, Fla.
			7–30	Carlstrom Field, Fla.
		Company E	1–29	With Transcontinental Motor Convoy.
			30	Camp A. A. Humphreys, Va.
	October	Regiment less Company C	1–31	Do.
		Company C	1–19	Carlstrom Field, Fla.
			20–22	En route to Camp A. A. Humphreys, Va.
			23–31	Camp A. A. Humphreys, Va.
1920	Nov. 1 to June 30	Regiment		Do.
	July	Regiment less Companies A, B, C, Band and Staff.	1– 8	Do.
			9–11	En route to Camp Funston, Kans.
			12–31	Camp Funston, Kans.
		Companies A, B, C, Band and Staff.	1–31	Camp A. A. Humphreys, Va.
	Aug. 1 to Nov. 30	Regiment less Companies A, B, C, Band and Staff.		Camp Funston, Kans.
		Companies A, B, C, Band and Staff.		Camp A. A. Humphreys, Va.
	December	Regiment less Companies A, B, C, Band and Staff.	1–14	Camp Funston, Kans.
			15–18	En route to Camp Meade, Md.
			19–31	Camp Meade, Md.
		Companies A, B, C, Band and Staff.	1–31	Camp A. A. Humphreys, Va.
1921	January	Regiment less Companies A, B, C, Band and Staff.	1–31	Camp Meade, Md.
		Companies A, B, C, Band and Staff.	1–12	Camp A. A. Humphreys, Va.
			13–31	Camp Meade, Md.
	Feb. 1 to Aug. 31	Regiment		Camp Meade, Md.
	September	do	1–21	Do.
			22–27	En route to Camp A. A. Humphreys, Va.[15]
1936	February	Regiment	1–29	Fort Belvoir, Va.[16]
	Mar. 1 to May 31	do		Fort Belvoir, Va.
	June	Regiment less Companies D and E.	1–30	Do.
		Company D	1–17	Do.
			18–30	Fort Knox, Ky.
		Company E	1–17	Fort Belvoir, Va.
			18–30	Camp Custer, Mich.
	July	Regiment less Companies D and E.	1–31	Fort Belvoir, Va.
		Company D	1–31	Fort Knox, Ky.
		Company E	1–23	Camp Custer, Mich.
			24–31	Dunningville, Mich.
	August	Regiment less Companies D and E.	1–31	Fort Belvoir, Va.
		Company D	1–13	Fort Knox, Ky.
			14–31	Fort Belvoir, Va.
	August	Company E	1–24	Camp Custer, Mich.
			25–31	Fort Belvoir, Va.

NOTE.—The entire personnel of the 1st Battalion (both assigned and attached) was transferred to the 13th Engineers, effective at midnight Jan. 12, 1921, in compliance with letter, Chief of Engineers 322.15 E–130, dated Jan. 6, 1921, and letter A. G. 320, 13th Engineers, dated Dec. 29, 1920.

---

[15] Regiment made inactive, at Camp Humphreys, Va., Sept. 27, 1921, personnel being transferred to 13th Engineers and surplus personnel organized into Training Companies Nos. 1, 2 and 3. Regiment inactive from Sept. 28, 1921 to Jan. 31, 1936, both dates inclusive.

[16] Regiment made active Feb. 1, 1936, and personnel, property, and funds transferred from 13th Engineers which was made inactive Jan. 31, 1936 at Fort Belvoir, Va.

Year	Month	Element	Dates	Station
1936	September	Regiment less 1st Battalion	1-30	Fort Belvoir, Va.
		1st Battalion	1-25	Do.
			26-30	Fort Meade, Md.
	October	Regiment less 1st Battalion	1-31	Fort Belvoir, Va.
		1st Battalion	1- 2	Fort Meade, Md.
			3-31	Fort Belvoir, Va.
	Nov. 1 to Dec. 31	Regiment		Do.
1937	January	Regiment less Company B	1-31	Do.
		Company B	1-26	Do.
			27	En route to Louisville, Ky.
			28-31	Louisville, Ky. (flood relief).
	February	Regiment less Company B	1-28	Fort Belvoir, Va.
		Company B	1- 6	Louisville, Ky. (flood relief).
			7	En route to Fort Belvoir, Va.
			8-28	Fort Belvoir, Va.
	Mar. 1 to May 31	Regiment		Do.
	June	Regiment less Company C	1-30	Do.
		Company C	1-15	Do.
			16	En route to Fort Knox, Ky.
			17-30	Fort Knox, Ky.
	July	Regiment less Company C	1-31	Fort Belvoir, Va.
		Company C	1-31	Fort Knox, Ky.
	August	Regiment less Company C	1-31	Fort Belvoir, Va.
		Company C	1- 2	Fort Knox, Ky.
			3	En route to Fort Belvoir, Va.
			4-31	Fort Belvoir, Va.
	September	Regiment less 2d Battalion	1-10	Practice march.
			11-30	Fort Belvoir, Va.
		2nd Battalion	1-10	Practice march.
			11-24	Fort Belvoir, Va.
			25-30	Corps Area maneuvers, Indiantown Gap, Pa.
	Oct. 1 to Dec. 31	Regiment		Fort Belvoir, Va.

FIFTH ENGINEER TRAIN

The Fifth Engineer Train was organized under the provisions of the Act of Congress approved June 3, 1916, under the designation First Engineer Train, Infantry, April 4, 1917, pursuant to letter A. G. 2416322–A dated March 21, 1917, and S. O. Number 93, Southern Department, 1917, at Leon Springs, Tex.; designation changed to the Fifth Engineer Train, per G. O. Number 48, Headquarters, Southern Department, dated July 29, 1917, pursuant to instructions of the War Department dated July 10, 1917.

Year	Month	Element	Dates	Station
1917	Apr. 1 to June 30	1st Engineer Train		Leon Springs, Tex.
	July	do	1–29	Do.
		5th Engineer Train	30–31	Do.
	Aug. 1 to Nov. 30	do		Do.
	December	do	1–13	Do.
			14–22	En route to Corpus Christi, Tex.
			23–31	Corpus Christi, Tex.
1918	Jan. 1 to June 30	do		Do.
	July	do	1–19	Do.
			20–24	En route to Camp Merritt, N. J.
			25–29	Camp Merritt, N. J.
			30	En route to board transport at Hoboken, N. J.
			31	Aboard U. S. S. *Mallory* en route to France.
	August	do	1–12	Aboard U. S. S. *Mallory* en route to Brest, France.
			13–31	With American Expeditionary Force in France.
1919	Sept. 1 to Jan. 31	do		Do.
	February	do	1–2	Saizerais, France.
			3–6	En route to Brest, France.
			7–12	Brest, France.
			13	Boarded U. S. S. *George Washington.*
			14	Aboard U. S. S. *George Washington.*
			15–25	En route to Hoboken, N. J.
			26–28	Camp Mills, N. Y.
	March	do	1–3	Do.
			4	En route to Camp A. A. Humphreys, Va.
			5–31	Camp A. A. Humphreys, Va.
1920	Apr. 1 to Dec. 31	do		Do.
1921	January	do	1–12	Do.

NOTE.—Personnel consisting of one enlisted man transferred to Hq. & Serv. Company, 13th Engineers on Jan. 13, 1921. Organization ceased to exist thereafter and final return rendered Jan. 12, 1921.

SIXTH ENGINEERS

The Sixth Regiment of Engineers was organized May 15, 1917, under the provisions of the act of Congress approved June 3, 1916, and pursuant to letter Headquarters, Eastern Department dated May 15, 1917, and War Department G. O. No. 62, 1917. Companies C and D of the former First Regiment were transferred as a nucleus for the Sixth Regiment and were designated as C and D companies respectively, of the Sixth Engineers. Companies A and B were formed by transfers from Company C and Companies E and F were formed by transfers from Company D. On May 22, 1917, the regiment went into camp in the suburbs of Washington, D. C., on the grounds of the American University.

Year	Month	Element	Dates	Station
1917	May	Regiment	16-21	Washington Barracks, D. C.
			22-31	Camp American University, D. C.
	June	do	1-30	Do.
	July	Regiment less 1st Battalion	1-31	Do.
		1st Battalion	1-23	Do.
			24-31	Camp Belvoir, Va.
	August	Regiment less 1st and 2d Battalion.	1-20	Camp American University, D. C.
			21-31	Washington Barracks, D. C.
		1st Battalion	1-22	Camp Belvoir, Va.
			23-31	Washington, Barracks, D. C.
		2d Battalion	1-20	Camp American University, D. C.
			20-22	Washington Barracks, D. C.
			23-31	Camp Belvoir, Va.
	September	Regiment less 2d Battalion	1-30	Washington Barracks, D. C.
		2d Battalion	1-20	Camp Belvoir, Va.
			21-30	Washington Barracks, D. C.
	Oct. 1 to Nov. 30	Regiment	------	Do.
	December	Regiment less 2d Battalion	1- 2	Do.
			3	En route to port of embarkation, Hoboken, N. J.
			4-21	Aboard U. S. S. *George Washington* en route to Brest, France.
			22-31	With American Expeditionary Force in France.
		2d Battalion	1- 2	Washington Barracks, D. C.
			3	En route to port of embarkation, Hoboken, N. J.
			4	Aboard U. S. S. *Huron*, Hoboken, N. J.
			5-22	Aboard U. S. S. *Huron* en route to St. Nazairre, France.
			23-31	With American Expeditionary Force in France.
1918 1919	Jan. 1 to July 31	Regiment	-------	With American Expeditionary Force in France and Germany.
	August	Regiment less Companies B and D.	1- 9	Ochtendung, Germany.
			10	En route to Plaidt, Germany.
			11-13	En route to Brest, France.
			14	Camp Pontanezen, Brest, France.
		Company B	1- 7	Ochtendung, Germany.
			8	En route to Mayen, Germany.
		Company B	9	Mayen, Germany.
			10	En route to Ochtendung, thence to Plaidt, Germany.
			11-13	En route to Brest, France.
			14	Camp Pontanezen, Brest, France.
		Company D	1- 6	Ochtendung, Germany.
			7	En route to Andernach, Germany.
			8-10	Andernach, Germany.
			11-14	En route to Brest, France. Rejoined regiment at Camp Pontanezen, Brest, France.

Year	Month	Element	Dates	Station
1919	August	Regiment	15–25	Aboard U. S. transport *Manchuria* en route to Hoboken, N. J. (Arrived Camp Merritt, N. J., 25th.)
			26–27	Camp Merritt, N. J.
			28–31	En route to Camp Pike, Ark.
1921	Sept. 1 to Aug. 31	Regiment		Camp Pike, Ark.
	September	Regiment less Company D	1–15	Do.
			16–21	En route to Camp Lewis, Wash.
			22–30	Camp Lewis, Wash.
		Company D	1–15	Camp Pike, Ark.
			16–21	En route to Camp Lewis, Wash.
			22–30	Fort Worden, Wash.
1922	Oct. 1 to Feb. 28	Regiment less Company D		Camp Lewis, Wash.
		Company D		Fort Worden, Wash.
	March	Regiment less Company D	1–31	Camp Lewis, Wash.
		Company D	1–24	Fort Worden, Wash.
			25–31	Camp Lewis, Wash.
	April	Regiment	1–30	Do.
	May	Regiment less Company D	1–31	Do.
		Company D	1–19	Do.
			20–31	Fort Worden, Wash.
	June 1 to July 31	Regiment less Company D		Camp Lewis, Wash.
		Company D		Fort Worden, Wash.
	August	Regiment less Companies D and E.	1–31	Camp Lewis, Wash.
		Company D	1–31	Fort Worden, Wash.
		Company E	1–25	Camp Lewis, Wash.
			26–30	En route to Fort Winfield Scott, Calif.
			31	Fort Winfield Scott, Calif.
	September	Regiment less Companies D and E.	1–30	Camp Lewis, Wash.
		Company D	1–30	Fort Worden, Wash.
		Company E[17]	1–30	Fort Scott, Calif.
1923	Oct. 1 to Apr. 30	Regiment less Companies D and E.		Camp Lewis, Wash.
		Company D		Fort Worden, Wash.
		Company E		Fort Winfield Scott, Calif.
	May	Regiment less Companies D and E.	1–31	Camp Lewis, Wash.
		Company D	1–31	Fort Worden, Wash.
		Company E	1–20	Fort Winfield Scott, Calif.
			21–31	Gigling Reservation, Calif.
	June	Regiment less Companies D and E.	1–30	Camp Lewis, Wash.
		Company D	1–30	Fort Worden, Wash.
		Company E	1–30	Gigling Reservation, Calif.
	July	Regiment less Companies D and E.	1–31	Camp Lewis, Wash.
		Company D	1–31	Fort Worden, Wash.
		Company E	1–11	Gigling Reservation, Calif.
			12–31	Camp Del Monte, Calif.
	August	Regiment less Companies D and E.	1–31	Camp Lewis, Wash.
		Company D	1–31	Fort Worden, Wash.
		Company E	1–24	Camp Del Monte, Calif.
			25–31	Fort Winfield Scott, Calif.
	Sept. 1 to Nov. 30	Regiment less Companies D and E.		Camp Lewis, Wash.
		Company D		Fort Worden, Wash.
		Company E		Fort Winfield Scott, Calif.
	December	Regiment less Companies D and E.	1–31	Camp Lewis, Wash.
		Company D	1–28	Fort Worden, Wash.
			29–31	Camp Lewis, Wash.
		Company E	1–31	Fort Winfield Scott, Calif.
1924	January	Regiment less Company E	1–31	Camp Lewis, Wash.
		Company E	1–31	Fort Winfield Scott, Calif.
	February	Regiment less Company E	1–29	Camp Lewis, Wash.
		Company E	1–15	Fort Winfield Scott, Calif.
			16–29	Fort Barry, Calif.
	March	Regiment less Company E	1–31	Camp Lewis, Wash.
		Company E	1–14	Fort Barry, Calif.
			15–31	Fort Winfield Scott, Calif.
	Apr. 1 to May 31	Regiment less Company E		Camp Lewis, Wash.
		Company E		Fort Winfield Scott, Calif.
	June	Regiment less Company E	1–30	Camp Lewis, Wash.
		Company E	1– 4	Fort Winfield Scott, Calif.
			5–30	Camp Del Monte, Calif.

[17] Company E absorbed personnel of Engineer Train Company No. 9.

Year	Month	Element	Dates	Station
1924	July	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1-31	Camp Del Monte, Calif. (summer training).
	August	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1-26	Camp Del Monte, Calif.
			27-31	Fort Winfield Scott, Calif.
	Sept. 1 to	Regiment less Company E		Camp Lewis, Wash.
1925	Jan. 31	Company E		Fort Winfield Scott, Calif.
	February	Regiment less Company E	1-28	Camp Lewis, Wash.
		Company E	1- 9	Fort Winfield Scott, Calif.
			10-28	Fort Barry, Calif.
	March	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1- 3	Fort Barry, Calif.
			4-31	Fort Winfield Scott, Calif.
	Apr. 1 to June 30	Regiment less Company E		Camp Lewis, Wash.
		Company E		Fort Winfield Scott, Calif.
	July	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1-14	Fort Winfield Scott, Calif.
			15-31	Camp Del Monte, Calif.
	August	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1-19	Camp Del Monte, Calif.
			20-31	Fort Winfield Scott, Calif.
	Sept. 1 to	Regiment less Company E		Camp Lewis, Wash.
1926	Jan. 31	Company E		Fort Winfield Scott, Calif.
	February	Regiment less Company E	1-28	Camp Lewis, Wash.
		Company E	1-14	Fort Winfield Scott, Calif.
			15-28	Fort Barry, Calif.
	March	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1- 7	Fort Barry, Calif.
			8-31	Fort Winfield Scott, Calif.
	Apr. 1 to May 31	Regiment less Company E		Camp Lewis, Wash.
		Company E		Fort Winfield Scott, Calif.
	June	Regiment less Company E	1-30	Camp Lewis, Wash.
		Company E	1-18	Fort Winfield Scott, Calif.
			19-30	Camp Del Monte, Calif.
	July	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1-26	Camp Del Monte, Calif.
			27-31	Fort Winfield Scott, Calif.
	Aug. 1 to Dec. 31	Regiment less Company E		Camp Lewis, Wash.
		Company E		Fort Winfield Scott, Calif.
1927	January	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1-26	Fort Winfield Scott, Calif.
			27-31	Fort Barry, Calif.
	February	Regiment less Company E	1-28	Camp Lewis, Wash.
		Company E	1-28	Fort Barry, Calif.
	March	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1- 6	Fort Barry, Calif.
			7	En route to Fort Winfield Scott, Calif.
			8-31	Fort Winfield Scott, Calif.
	Apr. 1 to May 31	Regiment less Company E		Camp Lewis, Wash.
		Company E		Fort Winfield Scott, Calif.
	June	Regiment less Company E	1-30	Camp Lewis, Wash.
		Company E	1-13	Fort Winfield Scott, Calif.
			14-30	Camp Del Monte, Calif.
	July	Regiment less Company E	1-31	Camp Lewis, Wash.
		Company E	1-26	Camp Del Monte, Calif.
			27-31	Fort Winfield Scott, Calif.

NOTE.—The Band was organized as a separate element at Camp Lewis, Wash., July 5, 1927, by transferring the Band Section from Hq. & Serv. Company, 6th Engineers—Letter A. G. 322.94, dated May 4, 1927.

Year	Month	Element	Dates	Station
	Aug. 1 to Sept. 30	Regiment less Company E		Camp Lewis, Wash.
		Company E		Fort Winfield Scott, Calif.
	October	Headquarters	1- 7	Fort Lewis, Wash.
			8-31	Fort Lawton, Wash.
		Hq. & Serv. Company (less Wagon Section).	1- 6	Fort Lewis, Wash.
			7-31	Fort Lawton, Wash.
		Company A	1-11	Fort Lewis, Wash.
			12-31	Fort Lawton, Wash.
		Headquarters 1st Battalion, Companies B and C.	1- 9	Fort Lewis, Wash.
			10-31	Fort Lawton, Wash.
		Wagon Section, Hq. & Serv. Company.	1- 9	Fort Lewis, Wash.
			10-12	En route to Fort Lawton, Wash.
			13-31	Fort Lawton, Wash.
		2d Battalion (less Company E)	1-31	Fort Lewis, Wash.
		Company E	1-31	Fort Winfield Scott, Calif.
	Nov. 1	Regiment less 2d Battalion		Fort Lawton, Wash.
	to	2d Battalion less Company E		Fort Lewis, Wash.
1928	Jan. 31	Company E		Fort Winfield Scott, Calif.

Year	Month	Element	Dates	Station
1928	February	Regiment less 2d Battalion	1–29	Fort Lawton, Wash.
		2d Battalion less Company E	1–29	Fort Lewis, Wash.
		Company E	1–3	Fort Winfield Scott, Calif.
			4–29	Fort Barry, Calif.
	March	Regiment less 2d Battalion	1–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Company E	1–7	Fort Barry, Calif.
			8–31	Fort Winfield Scott, Calif.
	Apr. 1 to May 31	Regiment less 2d Battalion		Fort Lawton, Wash.
		2d Battalion less Company E		Fort Lewis, Wash.
		Company E		Fort Winfield Scott, Calif.
	June	Regiment less 2d Battalion, Band, and Company B.	1–30	Fort Lawton, Wash.
		2d Battalion less Company E	1–30	Fort Lewis, Wash.
		Company E	1–17	Fort Winfield Scott, Calif.
			18–30	Camp Del Monte, Calif.
		Band	1–15	Fort Lawton, Wash.
			16–30	Fort Lewis, Wash.
		Company B [18]	1	Fort Lawton, Wash.
	July	Regiment less 2d Battalion, Band, and Company B.	1–31	Do.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Company E	1–31	Camp Del Monte, Calif.
		Band	1–25	Fort Lewis, Wash.
			26–31	Fort Lawton, Wash.
		Company B		Inactive.
	August	Regiment less 2d Battalion and Company B.	1–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Company E	1–3	Camp Del Monte, Calif.
			4–31	Fort Winfield Scott, Calif.
		Company B		Inactive.
1929	Sept. 1 to Apr. 30	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
		2d Battalion less Company E		Fort Lewis, Wash.
		Company E		Fort Winfield Scott, Calif.
		Company B		Inactive.
	May	Regiment less 1st and 2d Battalions.	1–31	Fort Lawton, Wash.
		1st Battalion less Company B	1–26	Do.
			27–31	Practice march.
		2d Battalion less Company E	1–28	Fort Lewis, Wash.
			29–31	Practice march.
		Company E	1–31	Fort Winfield Scott, Calif.
		Company B		Inactive.
	June	Regiment less 2d Battalion, Companies B, C, and Band.	1–30	Fort Lawton, Wash.
		2d Battalion less Company E	1–30	Fort Lewis, Wash.
		Company C	1–4	Fort Lawton, Wash.
			5–30	Fort Lewis, Wash.
		Company E	1–10	Fort Winfield Scott, Calif.
			11–12	Fort Barry, Calif.
			13–16	Fort Winfield Scott, Calif.
			17–30	Fort Barry, Calif.
		Band	1–20	Fort Lawton, Wash.
			21–30	Fort Lewis, Wash.
		Company B		Inactive.
	July	Regiment less 2d Battalion, Companies B, C, and Band.	1–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Company C	1–19	Do.
			20–31	Fort Lawton, Wash.
		Company E	1–24	Fort Barry, Calif.
			25–31	Fort Baker, Calif.
		Band	1–24	Fort Lewis, Wash.
			25–31	Fort Lawton, Wash.
		Company B		Inactive.
	August	Regiment less 2d Battalion and Company B.	1–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Company E	1–31	Fort Baker, Calif.
		Company B		Inactive.
	September	Regiment less 2d Battalion and Company B.	1–30	Fort Lawton, Wash.
		2d Battalion less Company E	1–30	Fort Lewis, Wash.
		Company E	1–6	Fort Baker, Calif.
			7–30	Fort Winfield Scott, Calif.
		Company B		Inactive.
1930	Oct 1 to Apr. 30	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
		2d Battalion less Company E		Fort Lewis, Wash.
		Company E		Fort Winfield Scott, Calif.
		Company B		Inactive.

[18] Company B rendered inactive at Fort Lawton, Wash., June 1, 1928.

Year	Month	Element	Dates	Station
1930	May	Regiment less 2d Battalion and Company B.	1-10	Fort Lawton, Wash.
			11-29	Practice march.
			30-31	Fort Lawton, Wash.
		2d Battalion less Company E	1-31	Fort Lewis, Wash.
		Company E	1-12	Fort Winfield Scott, Calif.
			13-30	Practice march.
			31	Fort Winfield Scott, Calif.
		Company B		Inactive.
	June	Regiment less 2d Battalion, Companies A, B, and Band.	1-30	Fort Lawton, Wash.
		2d Battalion less Company E	1-30	Fort Lewis, Wash.
		Company A	1- 3	Fort Lawton, Wash.
			4-30	Fort Lewis, Wash.
		Company E	1- 4	Fort Winfield Scott, Calif.
			5-30	Fort Barry, Calif.
		Band	1-13	Fort Lawton, Wash,
			14-30	Fort Lewis, Wash.
		Company B		Inactive
	July	Regiment less 2d Battalion, Companies A. B. and Band	1-31	Fort Lawton, Wash.
		2d Battalion less Company E	1-28	Fort Lewis, Wash.
			29-31	Practice march.
		Company A	1-16	Fort Lewis, Wash.
			17-31	Fort Lawton, Wash.
		Company E	1-31	Fort Barry, Calif.
		Band	1-17	Fort Lewis, Wash.
			18-31	Fort Lawton, Wash.
		Company B		Inactive.
	August	Regiment less 2d Battalion and Company B	1-31	Fort Lawton, Wash.
		2d Battalion less Company E	1-11	Practice march.
			12-31	Fort Lewis, Wash.
		Company E	1-29	Fort Barry, Calif.
			30-31	Fort Winfield Scott, Calif.
		Company B		Inactive.
	September	Regiment less 2d Battalion and Company B.	1-11	Fort Lawton, Wash.
			12-26	Fort Lewis, Wash.
			27-30	Fort Lawton, Wash.
		2d Battalion less Company E	1-30	Fort Lewis, Wash.
		Company E	1-30	Fort Winfield Scott, Calif.
		Company B		Inactive.
	October	Regiment less 2d Battalion and Company B.	1-31	Fort Lawton, Wash.
		2d Battalion less Company E	1-31	Fort Lewis, Wash.
		Company E	1-31	Fort Winfield Scott, Calif.
		Company B		Inactive.
	November	Regiment less 2d Battalion and Company B.	1-30	Fort Lawton, Wash.
		2d Battalion less Company E	1-30	Fort Lewis, Wash.
		Company E [18]	1-30	Fort Winfield Scott. Calif.
		Company B		Inactive.
	Dec. 1 to Apr. 30	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
1931		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.
	May	Regiment less 2d Battalion and Company B.	1-24	Fort Lawton, Wash.
		Do	25-29	Practice march to Fort Lewis, Wash.
			29-31	Fort Lewis, Wash
		2d Battalion less Company E	1-31	Do.
		Companies B and E		Inactive.
	June	Regiment less 2d Battalion and Companies B and C.	1- 3	Fort Lewis, Wash.
			4-30	Fort Lawton, Wash.
		2d Battalion (less Co. E) and Company C.	1-30	Fort Lewis, Wash.
		Companies B and E		Inactive.
	July	Regiment less 2d Battalion, Companies B, C, and Band.	1-31	Fort Lawton, Wash.
		Company C	1-18	Fort Lewis, Wash.
			19-31	Fort Lawton, Wash.
		2d Battalion less Company E	1-31	Fort Lewis, Wash.
		Band	1-15	Do
			16-31	Fort Lawton, Wash.
		Companies B and E		Inactive.
	August	Regiment less 2d Battalion and Company B.	1-31	Fort Lawton, Wash.
		2d Battalion less Company E	1-31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	September	Regiment less 2d Battalion and Company B.	1-18	Practice march.
			19-30	Fort Lawton, Wash.

[18] Company E rendered inactive at Fort Winfield Scott, Calif., Nov. 30, 1930.

Year	Month	Element	Dates	Station
1931	September	2d Battalion less Company E	1–14	Practice march.
			15–30	Fort Lewis, Wash.
		Companies B and E		Inactive.
	Oct. 1 to Apr. 30	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
1932		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.
	May	Regiment less 2d Battalion and Company B.	1	Fort Lawton, Wash.
			2–26	Fort Lewis, Wash.
			27–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	June	Regiment less 2d Battalion, Companies A, B and Band.	1–30	Fort Lawton, Wash.
		2d Battalion less Company E	1–30	Fort Lewis, Wash.
		Company A	1–13	Fort Lawton, Wash.
			14–30	Fort Lewis, Wash.
		Band	1–17	Fort Lawton, Wash.
			18–30	Fort Lewis, Wash.
		Companies B and E		Inactive.
	July	Regiment less 2d Battalion, Companies A, B, and Band.	1–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Company A and Band	1–16	Do.
			17–30	Fort Lawton, Wash.
		Companies B and E		Inactive.
	August	Regiment less 2d Battalion and Company B.	1–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–15	Practice march.
			16–31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	September	Regiment less 2d Battalion and Companies A, B, and C.	1–30	Fort Lawton, Wash.
		Company A	1–11	Do.
			12–16	Sammamish Lake, Wash.
			17–27	Fort Lawton, Wash.
			28–29	Practice march.
			30	Fort Lawton, Wash.
		Company C	1–5	Do.
			6–10	Sammamish Lake, Wash.
			11–26	Fort Lawton, Wash.
			27–28	Practice march.
			29–30	Fort Lawton, Wash.
		2d Battalion less Company E	1–30	Fort Lewis, Wash.
		Companies B and E		Inactive.
	Oct. 1 to Mar. 31	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
1933		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.
	April	Regiment less 2d Battalion and Company B.	1–30	Fort Lawton, Wash.
		2d Battalion less Company E	1–17	Fort Lewis, Wash.
			18–30	Practice march.
		Companies B and E		Inactive.
	May	Regiment less 2d Battalion and Company B.	1–31	Fort Lawton, Wash.
		2d Battalion less Company E	1	Practice march.
			2–31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	June	Regiment less 2d Battalion, Companies B, C, and Band.	1–30	Fort Lawton, Wash.
		Company C and Band	1–16	Do.
			17–30	Fort Lewis, Wash.
		2d Battalion less Company E	1–30	Do.
		Companies B and E		Inactive.
	July	Regiment less 2d Battalion, Companies B, C, and Band.	1–31	Fort Lawton, Wash.
		Company C and Band	1–18	Fort Lewis, Wash.
			19–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	August	Regiment less 2d Battalion and Companies A, B, and C.	1–21	Fort Lawton, Wash.
		Company A	1– 3	Do.
			4–13	Lake Sammamish, Wash.
			14–31	Fort Lawton, Wash.
		Company C	1–13	Do.
			14–23	Lake Sammamish, Wash.
			24–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	Sept. 1 to Mar. 31	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
1934		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.

Year	Month	Element	Dates	Station
1934	April	Regiment less 2d Battalion and Company B.	1–30	Fort Lawton, Wash.
		2d Battalion less Company E	1–25	Fort Lewis, Wash.
			26–30	Practice march.
		Companies B and E		Inactive.
	May	Regiment less 2d Battalion and Company B.	1–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–9	Practice march.
			10–31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	June	Regiment less 2d Battalion and Companies A and B.	1–8	Practice march.
			9–30	Fort Lawton, Wash.
		Company A	1–8	Practice march.
			9–25	Fort Lawton, Wash.
			26–30	Fort Lewis, Wash.
		2d Battalion less Company E	1–30	Do.
		Companies B and E		Inactive.
	July	Regiment less 2d Battalion and Companies A and B.	1–31	Fort Lawton, Wash.
		Company A	1–31	Fort Lewis, Wash.
		2d Battalion less Company E	1–31	Do.
		Companies B and E		Inactive.
	August	Regiment less 2d Battalion, Companies A, B, C, and Band.	1–31	Fort Lawton, Wash.
		Company A	1– 3	Fort Lewis, Wash.
			4–31	Fort Lawton, Wash.
		Company C and Band	1–19	Do.
			20–30	Lake Sammamish, Wash.
			31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	September	Regiment less 2d Battalion and Companies A and B.	1–30	Fort Lawton, Wash.
		Company A	1–2	Do.
			3–13	Lake Sammamish, Wash.
			14–30	Fort Lawton, Wash.
		2d Battalion less Company E	1–30	Fort Lewis, Wash.
		Companies B and E		Inactive.
	Oct. 1 to Feb. 28	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
1935		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.
	March	Regiment less 2d Battalion and Company B.	1–31	Fort Lawton, Wash.
		2d Battalion less Company E	1–26	Fort Lewis, Wash.
			27	Fort Lawton, Wash.
			28–31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	April	Regiment less 2d Battalion and Company B.	1–30	Fort Lawton, Wash.
		2d Battalion less Company E	1–30	Fort Lewis, Wash.
		Companies B and E		Inactive.
	May	Regiment less Companies B and E.	1–8	Practice march.
			9–30	Fort Lewis, Wash.
		Regiment less 2d Battalion and Company B.	31	Fort Lawton, Wash.
		2d Battalion less Company E	31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	June 1 to July 31	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.
	August	Regiment less 2d Battalion and Companies A and B.	1–31	Fort Lawton, Wash.
		Company A	1–18	Do.
			19–30	Lake Sammamish, Wash.
			31	Fort Lawton, Wash.
		2d Battalion less Company E	1–31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	September	Regiment less Companies B, C, and E.	1–30	Fort Lawton, Wash.
		Company C	1– 2	Do.
			3–13	Lake Sammamish, Wash.
		Companies B and E		Inactive.
	Oct. 1 to Apr. 30	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
1936		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.
	May	Regiment less 2d Battalion and Company B.	1–7	Fort Lawton, Wash.
			8–28	Fort Lewis, Wash.
			29–31	Practice march.
		2d Battalion less Company E	1–28	Fort Lewis, Wash.
			29–31	Practice march.
		Companies B and E		Inactive.
	June	Regiment less 2d Battalion and Company B.	1–13	Practice march.
			14–30	Fort Lawton, Wash.

Year	Month	Element	Dates	Station
1936	June	2d Battalion less Company E	1-13	Practice march.
			14-30	Fort Lewis, Wash.
		Companies B and E		Inactive.
	July 1 to Aug. 31	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.
	September	Regiment less 2d Battalion and Companies A and C.	1-30	Fort Lawton, Wash.
		Company A	1-20	Do.
			21	Fort Lewis, Wash.
			22-23	Fort Lawton, Wash.
			24-30	Lake Stevens, Wash.
		Company C	1-7	Fort Lawton, Wash.
			8-18	Lake Stevens, Wash.
			19-21	Fort Lawton, Wash.
			22	Fort Lewis, Wash.
			23-30	Fort Lawton, Wash.
		2d Battalion less Company E	1-30	Fort Lewis, Wash.
		Companies B and E		Inactive.
	October	Regiment less 2d Battalion, Companies A and B.	1-31	Fort Lawton, Wash.
		Company A	1-3	Lake Stevens, Wash.
			4-31	Fort Lawton, Wash.
		2d Battalion less Company E	1-31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	Nov. 1 to Dec. 31	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.
1937	Jan. 1 to Mar. 31	Regiment less 2d Battalion and Company B.		Fort Lawton, Wash.
		2d Battalion less Company E		Fort Lewis, Wash.
		Companies B and E		Inactive.
	April	Regiment less 2d Battalion and Company B.	1-20	Fort Lawton, Wash.
			21-30	Fort Lewis, Wash.
		2d Battalion less Company E	1-30	Do.
		Companies B and E		Inactive.
	May	Regiment less Hq. & Serv. Company and Companies B and E.	1-31	Fort Lewis, Wash.
		Hq. & Serv. Company	1-28	Do.
			29-31	Fort Lawton, Wash.
		Companies B and E		Inactive.
	June	Regiment less 2d Battalion, Hq. & Serv. Company and Company B.	1-8	Fort Lewis, Wash.
			9-15	Fort Lawton, Wash.
			16-30	Practice march.
		2d Battalion less Company E	1-15	Fort Lewis, Wash.
			16-30	Practice march.
		Hq. & Serv. Company	1-30	Fort Lawton, Wash.
		Companies B and E		Inactive.
	July	Regiment less 2d Battalion, Hq. & Serv. Company and Company B.	1-5	Practice march.
			6-31	Fort Lawton, Wash.
		2d Battalion less Company E	1-5	Practice march.
			6-31	Fort Lewis, Wash.
		Hq. & Serv. Company	1-31	Fort Lawton, Wash.
		Companies B and E		Inactive.
	August	Regimental Headquarters and Band.	1-12	Fort Lawton, Wash.
			13-27	Fort Lewis, Wash.
			28-31	Fort Lawton, Wash.
		Hq. & Serv. Company	1-31	Do.
		1st Battalion less Companies A and B.	1-12	Do.
			13-31	Do.
		Company A	1-12	Fort Lawton, Wash.
			13-30	Fort Lewis, Wash.
			31	Fort Lawton, Wash.
		2d Battalion less Company E	1-31	Fort Lewis, Wash.
		Companies B and E		Inactive.
	Sept. 1 to Dec. 31	Regiment less 2d Battalion and Company B.	1-30	Fort Lawton, Wash.
		2d Battalion less Company E	1-30	Fort Lewis, Wash.
		Companies B and E		Inactive.

SIXTH ENGINEER TRAIN

The Sixth Engineer Train was organized on August 20, 1917, at Washington Barracks, D. C., under the provisions of the Act of Congress approved May 18, 1917, and pursuant to first indorsement, A. G. O. 2605788, dated June 9, 1917, and Regimental Order No. 57, Sixth Engineers, dated August 18, 1917.

Year	Month	Element	Dates	Station
1917	Aug. 1 to Oct. 31	Train		Washington Barracks, D. C.
	November	do	1-16	Do.
			17	En route to Newport News, Va.
			18-30	Newport News, Va.
	December	do	1-7	Do.
			8-18	Aboard U. S. Army cargo transport *Eagle* en route to New York and awaiting departure of convoy.
			19-31	Aboard U. S. Army cargo transport *Eagle* en route to France.
1918	January	do	1	Aboard U. S. Army cargo transport *Eagle* returning to Hoboken, with damaged steering gear.
			2-4	Aboard U. S. Army cargo transport *Eagle* at Hoboken, N. J.
			5-18	Aboard U. S. Army cargo transport *Eagle*, pier 45, Mallory Line, North River, New York City.
		do	19-31	Aboard U. S. Army cargo transport *Eagle* en route to France.
	February	do	1-7	Aboard U. S. Army cargo transport *Eagle* en route to La Pallice, France.
			8-28	With American Expeditionary Force in France.
1919	Mar. 1 to July 31	do		With American Expeditionary Force in France and Germany.
	August	do	1-8	Ochtendung, Germany.
			9	Marched to Plaidt, Germany.
			10-12	En route to Brest, France.
			13-23	Aboard U. S. S. *Sol Mavis* en route to Hoboken, N. J. (Arrived Camp Merritt, N. J., same day.)
			24-26	Camp Merritt, N. J.
			27-30	En route to Camp Pike, Ark.
			31	Camp Pike, Ark.
1920	Sept. 1 to Nov. 30	do		Do.
	December	do	1-31	Camp Pike, Ark. (No personnel assigned during December.)
		Organization demobilized per change Sheet No. 27, Apr. 11, 1921		

SEVENTH ENGINEERS

Under the provisions of the Act of Congress approved June 3, 1916, and pursuant to instructions contained in letter Headquarters, Eastern Department, dated May 15, 1917, and War Department General Order No. 62, 1917, the Seventh United States Engineers was created by expansion of Companies E and F, First U. S. Engineers, on May 15, 1917. Regimental Headquarters and the First Battalion, Seventh United States Engineers, were formed from Company E, First United States Engineers, and the Second Battalion, Seventh United States Engineers, was formed from Company F, First United States Engineers.

Year	Month	Element	Dates	Station
1917	May	Regimental Headquarters and 1st Battalion 7th U. S. Engineers (Company E, 1st U. S. Engineers), entrained at Washington, D. C., 5 p. m. May 23, 1917, arriving at Fort Leavenworth, Kans., for station at 3 a. m., May 26, 1917. At Fort Leavenworth, Kans., from 27th to 31st, inclusive.		
		Company F, 7th U. S. Engineers (Companys D, E, F—2d Battalion) stationed at Leon Springs, Tex., from 16th to 29th., inclusive. Entrained 30th en route to Fort Leavenworth, Kans., for station, arriving at 11 a. m., June 1, 1917.		
  1918	June 1 to Jan. 31	Regiment		Fort Leavenworth, Kans.
	February	do	1–24	Do.
			25–28	En route to Camp Merritt, N J., in 4 sections. Sections 1 and 2 arrived 28th.
	March	do	1	En route to Camp Merritt, N. J. Sections 3 and 4 arriving Mar. 1.
			2– 5	Camp Merritt, N. J.
		Regiment less 2d Battalion	6–14	Do.
			15	En route to Hoboken, N. J., and boarded R. M. S. *Orduna*.
			16–28	En route to Liverpool, England.
			29–31	Rest Camp, Winchester, England.
		2d Battalion	6–18	Aboard U. S. S. *Celtic* en route to Liverpool, England.
			19	En route to Southampton, England (via Halifax, Nova Scotia).
			22–23	En route to Havre, France.
			24–31	With American Expeditionary Forces in France.
	April	Regiment less 2d Battalion	1–4	Rest Camp, Winchester, England.
			5– 6	En route to Havre, France.
			7–30	With American Expeditionary Forces in France.
  1919	May 1 to June 30	Regiment		With American Expeditionary Forces in France and Luxemburg.
	July	Regiment less 2d Battalion	1– 8	Rumelange, Luxemburg.
			9–11	En route to Brest, France.
			12–14	Brest, France.
		2d Battalion	1–11	Pershing Stadium, Paris, France.
			12–13	En route to Brest, France.
			14	Brest, France.
		Regiment	15	Boarded U. S. S. *Radnor*.
			16–28	Aboard U. S. S. *Radnor* en route to Hoboken, N. J. (Arrived Camp Merritt, N. J., same day.)
			29–30	Camp Merritt, N. J.
			31	En route to Camp Gordon, Ga.

Year	Month	Element	Dates	Station
1919	August	Regiment	1- 2	En route to Camp Gordon, Ga.
			3-31	Camp Gordon, Ga.
  1920	Sept. 1 to Mar. 31	do		Do.
	April	Regiment less Company D	1-30	Do.
		Company D	1- 9	Do.
			10-30	Camp Benning, Ga.
	May 1 to Aug. 31	Regiment less Company D		Camp Gordon, Ga.
		Company D		Camp Benning, Ga.
	September	Regiment less Company D	1-22	Camp Gordon, Ga.
			23-24	En route to Camp Jackson, S. C.
			25-31	Camp Jackson, S. C.
		Company D	1-31	Camp Benning, Ga.
  1921	Oct. 1 to May 31	Regiment less Company D Company D		Camp Jackson, S. C. Camp Benning, Ga.
	June	Regiment less Companies D and E.	1-30	Camp Jackson, S. C.
		Company D	1-30	Camp Benning, Ga.
		Company E	1-29	Camp Jackson, S. C.
			30	En route to Camp Benning, Ga.
	July 1 to Sept. 30	Regiment less Companies D and E.		Camp Jackson, S. C.
		Companies D and E		Camp Benning, Ga.
	October	Regiment less Companies A, D, and E.	1- 9	Camp Jackson, S. C.
			10	Placed on inactive list.
		Company A	1-31	Camp Benning, Ga.
		Companies D and E	1- 9	Do.
			10	Placed on inactive list.
  1922	Nov. 1 to Jan. 31	Company A Regiment less Company A		Camp Benning, Ga. Inactive.
  1931	Feb. 1 to July 31	Company A Regiment less Company A		Fort Benning, Ga. Inactive.
  1933	Aug. 1 to Sept. 30	Company A (less 1 platoon) Regiment less Company A (less 1 platoon).		Fort Benning, Ga. Inactive.

NOTE.—Company A, 7th Engineers rendered inactive Sept. 30, 1933. Personnel transferred to Company A, 4th Engineers Oct. 1, 1933.

  1937	Oct. 1 to Dec. 31	Regiment		Inactive.

SEVENTH ENGINEER TRAIN

The Seventh Engineer Train was organized under the provisions of the Act of Congress approved May 18, 1917, on September 1, 1917, at Fort Leavenworth, Kans., pursuant to first endorsement A. G. O. 2605788, dated June 9, 1917, and pursuant to Regimental Order No. 83, Seventh Engineers, 1917.

Year	Month	Element	Dates	Station
1917 1918	Sept. 1 to Jan. 31	Train		Fort Leavenworth, Kans.
	February	do	1-24	Do.
			25-28	En route to Camp Merritt, N. J.
	March	do	1	Do.
			2-14	Camp Merritt, N. J.
			15	En route to Hoboken, N. J., and boarded R. M. S. *Orduna*.
			16-28	En route to Liverpool, England.
			29-31	Winnall Down Camp, Winchester, England.
	April	do	1- 4	Do.
			5- 6	En route to Havre, France.
			7-30	With American Expeditionary Forces in France.
  1919	May 1 to June 30	do		With American Expeditionary Forces in France and Luxemburg.
	July	do	1- 8	Rumelange, Luxemburg.
			9-11	En route to Brest, France.
			12-14	Brest, France.
			15	Boarded U. S. S. *Radnor*.
			16-28	Aboard U. S. S. *Radnor* en route to Hoboken, N. J. (Arrived Camp Merritt, N. J. same day.)
			29-30	Camp Merritt, N. J.
			31	En route to Camp Gordon, Ga.
1920	Aug. 1 to Aug. 31	do		Camp Gordon, Ga.
	September	do	1-22	Do.
			23-24	En route to Camp Jackson, S. C.
			25-31	Camp Jackson, S. C.
	Oct. 1 to Dec. 31	do		Do.
1921	January	do	1-22	Do.

NOTE.—There was no personnel assigned to the 7th Engineer Train from June 1, 1920, to Jan. 22, 1921. The train was discontinued in accordance with War Department Circular No. 400, 1920, and the final return rendered on Jan. 22, 1921.

EIGHTH ENGINEERS (SQUADRON)

Company A, First Battalion Mounted Engineers, was organized at Twin Windmills, Mexico, August 20, 1916, under the provisions of the Act of Congress approved June 3, 1916, War Department S. O. No. 144, 1916, G. O. No. 22, War Department, 1916, and R. G. O. No. 2, Second Regiment Engineers, 1916, by transfers from Companies E, G, and H, Second Battalion of Engineers.

Year	Month	Element	Dates	Station
1916	August	Company A	20-31	With Punitive Expedition in Mexico (attached to 2d Regiment of Engineers).
  1917	Sept. 1 to Jan. 31	do		Do.
	February	do	1- 4	Do.
			5	En route from Palomas, Mexico to Columbus, N. Mex.
			6- 7	Columbus, N. Mex.
			8- 9	En route to Camp Stewart, El Paso, Tex.
			10-28	Camp Stewart, El Paso, Tex.
	March	do	1-12	Do.
			13-31	Camp Newton D. Baker, El Paso, Tex.
	April	do	1-30	Do.
	May	do	1-20	Do.

NOTE.—Company A expanded into 1st and 2d Battalions of Mounted Engineers, per G. O. No. 62, War Department, 1917. Battalion Headquarters and Companies B and C, 1st Battalion Mounted Engineers organized May 21, 1917, at Camp Newton D. Baker, El Paso, Tex., from Company A, 1st Mounted Battalion of Engineers in accordance with G. O. No. 62, War Department, 1917, and pursuant to G. O. 6, Headquarters 2nd Regiment of Engineers, dated May 21, 1917. Redesignated as 8th Engineers (Mounted) per G. O. No. 48, Headquarters Southern Department, dated July 29, 1917, pursuant to instructions from the War Department dated July 10, 1917.

Year	Month	Element	Dates	Station
	May	Battalion less Company A	21-31	Camp Stewart, Fort Bliss, Tex.
		Company A	1-20	Camp Newton D. Baker, El Paso Tex.
			21-31	Camp Stewart, Fort Bliss, Tex.
	June 1 to Sept. 30	Battalion		Do.
	October	do	1-29	Do.
			30	Camp Courchesne, N. Mex.
	November	do	1-29	Camp Courchesne, N. Mex., and Camp Baker, Fort Bliss, Tex.
			30	Camp Baker, Fort Bliss, Tex.
  1918	Dec. 1 to June 30	do		Do.
	July	do	1-14	Do.
			15-22	En route to Camp Head Springs, Mescalero, N. Mex.
			23-31	Camp Head Springs, Mescalero, N. Mex.
	August	do	1-14	Do.
			15-22	En route to Camp Baker, Fort Bliss, Tex.
			23-31	Camp Baker, Fort Bliss, Tex.
	Sept. 1 to Dec. 31	do		Do.
1919	January	Battalion less Company B	1-31	Do.
		Company B	1-26	Do.
			27-30	En route to Camp McArthur, Waco, Tex.
			31	Camp McArthur, Waco, Tex.
	Feb. 1 to Mar. 31	Battalion less Company B		Camp Baker, Fort Bliss, Tex.
		Company B		Camp McArthur, Waco, Tex.
	April	Battalion less Company B	1-30	Camp Baker, Fort Bliss, Tex.
		Company B	1	Camp McArthur, Waco, Tex.
			2- 4	En route to Camp Baker, Fort Bliss, Tex.
			5-30	Camp Baker, Fort Bliss, Tex.

Year	Month	Element	Dates	Station
1919	May	Battalion	1–31	Camp Baker, Fort Bliss, Tex.
	June	do	1–14	Do.
			15–16	Engaged with 2d Cavalry Brigade in operations against Villista Forces in Mexico.
			17–30	Camp Baker, Fort Bliss, Tex.
	July	do	1–11	Do.
			12–16	En route to Camp Wagner, Cloudcroft, N. Mex.
			17–31	Camp Wagner, Cloudcroft, N. Mex.
	August	do	1–15	Do.
			16–18	En route to Camp Baker, Fort Bliss, Tex.
	Sept. 1			
	to	do		Camp Baker, Fort Bliss, Tex.
1920	June 30			
	July	do	1–20	Do.
			21–27	En route to Camp Dickman, Elephant Butte Dam, N. Mex.
			28–31	Camp Dickman, Elephant Butte Dam, N. Mex.
	August	do	1–3	Do.
			4–10	En route to Fort Bliss, Tex.
			11–31	Fort Bliss, Tex.
	Sept. 1			
	to	do		Do.
1921	May 31			
	June	Battalion less Company A	1–30	Do.
		Company A	1–14	Do.
			15–30	Pueblo, Colo. (flood relief).
	July	Battalion less Company A	1–31	Fort Bliss, Tex.
		Company A	1–31	Pueblo, Colo. (flood relief).
	August	Battalion less Company A	1–31	Fort Bliss, Tex.
		Company A	1–16	Pueblo, Colo. (flood relief).
			17–31	Fort Bliss, Tex.
	Sept. 1			
	to	Battalion		Do.
1926	July 31			
	August	do	1–16	Do.
			17–21	En route to Columbus, N. Mex.
			22–31	Camp Furlong, Columbus, N. Mex.
	Sept. 1 to Oct. 31	do		Do.
	November	do	1–14	Do.
			15–18	En route to Fort Bliss, Tex.
			19–30	Fort Bliss, Tex.
	Dec. 1			
	to	do		Do.
1927	Apr. 30			
	May	do	1–5	Do.
			6–7	Dona Anna target range.
			8–31	Fort Bliss, Tex.
	June 1 to July 31	do		Do.
	August	do	1–23	Do.
			24–25	Courchesne Bridge, N. Mex.
			26–31	Fort Bliss, Tex.
	September	do	1–9	Do.
			10–18	En route to Camp Marfa, Tex.
			19–30	Camp Marfa, Tex.
	October	do	1–4	Do.
			5–12	En route to Fort Bliss, Tex.
			13–31	Fort Bliss, Tex.
	Nov. 1			
	to	do		Do.
1928	Apr. 30			
	May	do	1–10	Do.
			11–13	En route to Fort McIntosh, Tex.
			14–31	Fort McIntosh, Tex.
	June 1			
	to	do		Do.
1929	Apr. 30			
	May	do	1–21	Do.
			22–26	Practice march.
			27–31	Fort McIntosh, Tex.
	June 1 to Aug. 31	do		Do.
	September	Battalion less Company B	1–30	Do.
		Company B	1–20	Do.
			21–30	Fort Bliss, Tex.
	October	Battalion less Company B	1–31	Fort McIntosh, Tex.
		Company B	1–31	Fort Bliss, Tex.
	November	Battalion less Company B	1–30	Fort McIntosh, Tex.
		Company B	1–11	Fort Bliss, Tex.
			12–17	En route to Fort McIntosh, Tex.
			18–30	Fort McIntosh, Tex.

Year	Month	Element	Dates	Station
1929	December	Battalion less Company B	1	Fort McIntosh, Tex.
			2-14	Practice march.
			15-31	Fort McIntosh, Tex.
		Company B	1-31	Do.
1930	Jan. 1 to Mar. 31	Battalion		Do.
	April	Battalion less Companies B and C.	1-30	Do.
		Company B	1-29	Do.
			30	En route to Encinal, Tex.
		Company C	1-13	Fort McIntosh, Tex.
			14-30	Maneuvers, 1st Cavalry Division.
	May	Battalion less Companies B and C.	1-31	Fort McIntosh, Tex.
		Company B	1-19	Maneuvers, 1st Cavalry Division.
			20-31	Fort McIntosh, Tex.
		Company C	1-14	Maneuvers, 1st Cavalry Division.
			15-31	Fort McIntosh, Tex.

NOTE.—The Eighth Engineer Battalion reorganized June 1, 1930, per letter Adjutant General 320.2 Engineers (10-11-29) Misc. (Returns) C dated Mar. 26, 1930. Designation changed to 8th Engineer Squadron. Squadron consisted of Hq. & Serv. Troop and Troops A, B, and C. Company C, 8th Engineer Battalion redesignated Troop C, 8th Engineer Squadron and placed on the inactive list.

Year	Month	Element	Dates	Station
	June	Squadron less Troop C	1-30	Fort McIntosh, Tex.
		Troop C		Inactive.
	July 1 to Jan. 31	Squadron less Troop C		Fort McIntosh, Tex.
1931		Troop C		Inactive.
	February	Squadron less Troops B and C	1-28	Fort McIntosh, Tex.
		Troop B	1-24	Do.
			25-28	En route to Fort Bliss, Tex.
		Troop C		Inactive.
	March	Squadron less Troops B and C	1-31	Fort McIntosh, Tex.
		Troop B	1	En route to Fort Bliss, Tex.
			2-31	Fort Bliss, Tex.
		Troop C		Inactive.
	Apr. 1 to May 31	Squadron less Troops B and C		Fort McIntosh, Tex.
		Troop B		Fort Bliss, Tex.
		Troop C		Inactive.
	June	Squadron less Troops B and C	1-30	Fort McIntosh, Tex.
		Troop B	1- 6	Do.
			7- 9	En route to Fort McIntosh, Tex.
			10-30	Fort McIntosh, Tex.
		Troop C		Inactive.
	July	Squadron less Troop C	1-31	Fort McIntosh, Tex.
		Troop C		Inactive.
	August	Squadron less Hq. & Serv. Troop and Troop C.	1-31	Fort McIntosh, Tex.
		Hq. & Serv. Troop	1-11	Do.
			12-25	Practice march.
			26-31	Fort McIntosh, Tex.
		Troop C		Inactive.
	Sept. 1 to Nov. 30	Squadron less Troop C		Fort McIntosh, Tex.
		Troop C		Inactive.
	December	Squadron less Troops A and C	1-31	Fort McIntosh, Tex.
		Troop A	1	Do.
			2-16	Practice march.
			17-31	Fort McIntosh, Tex.
		Troop C		Inactive.
1932	Jan. 1 to Apr. 30	Squadron less Troop C		Fort McIntosh, Tex.
		Troop C		Inactive.
	May	Squadron less Troops A and C	1-11	Fort McIntosh, Tex.
			12-25	Maneuvers.
			26-31	Fort McIntosh, Tex.
		Troop A	1- 6	Fort McIntosh, Tex.
			7-31	Maneuvers.
		Troop C		Inactive.
	June 1 to Apr. 30	Squadron less Troop C		Fort McIntosh, Tex.
1933		Troop C		Inactive.
	May	Squadron less Troop C	1	Fort McIntosh, Tex.
			2-13	Practice march.
			14-31	Fort McIntosh, Tex.
		Troop C		Inactive.
	June 1 to July 31	Squadron less Troop C		Fort McIntosh, Tex.
		Troop C		Inactive.
	August	Squadron less Troops B and C	1-31	Fort McIntosh, Tex.
		Troop B	1-28	Do.
			29-31	Point Isabel, Tex. (recreation camp).
		Troop C		Inactive.
	September	Squadron less Troops B and C	1-30	Fort McIntosh, Tex.
		Troop B	1- 4	Point Isabel, Tex.
			5-30	Fort McIntosh, Tex.
		Troop C		Inactive.

Year	Month	Element	Dates	Station
1933	October	Squadron less Troops A and C	1–31	Fort McIntosh, Tex.
		Troop A	1– 2	Do.
			3–14	Recreation camp (New Braunfels, Tex.).
			15–31	Fort McIntosh, Tex.
		Troop C		Inactive.
	Nov. 1 to Mar. 31	Squadron less Troop C		Fort McIntosh, Tex.
1935		Troop C		Inactive.
	April	Squadron less Troop C	1– 7	Fort McIntosh, Tex.
			8–20	Practice march.
			21–30	Fort McIntosh, Tex.
		Troop C		Inactive.
	May 1 to June 30	Squadron less Troop C		Fort McIntosh, Tex.
		Troop C		Inactive.
	July	Squadron less Troops A, B, and C.	1–31	Fort McIntosh, Tex.
		Troop A	1–19	Do.
			20–27	Practice march.
			28–31	Fort McIntosh, Tex.
		Troop B	1–12	Do.
			13–19	Practice march.
			20–31	Fort McIntosh, Tex.
		Troop C		Inactive.
	Aug. 1 to Mar. 31	Squadron less Troop C		Fort McIntosh, Tex.
1936		Troop C		Inactive.
	April	Squadron less Hq. & Serv. Troop and Troop C.	1–16	Fort McIntosh, Tex.
			17–30	Maneuvers (Fort D. A. Russell, Tex.).
		Hq. & Serv. Troop	1–30	Fort McIntosh, Tex.
		Troop C		Inactive.
	May	Squadron less Hq. & Serv. Troop and Troop C.	1–11	Maneuvers (Marfa, Tex.).
			12–13	En route to Fort McIntosh, Tex.
			14–31	Fort McIntosh, Tex.
		Hq. & Serv. Troop	1–31	Do.
		Troop C		Inactive.
	June	Squadron less Troop C	1–30	Fort McIntosh, Tex.
		Troop C		Inactive.
	July	Squadron less Troops B and C	1–26	Fort McIntosh, Tex
			27–31	Practice march.
		Troop B	1–31	Fort McIntosh, Tex.
		Troop C		Inactive.
	August	Squadron less Hq. & Serv. Troop and Troop C.	1–23	Fort McIntosh, Tex.
			24–28	Practice march.
			29–31	Fort McIntosh, Tex.
		Hq. & Serv. Troop	1–31	Do.
		Troop C		Inactive.
	Sept. 1 to Dec. 31	Squadron less Troop C		Fort McIntosh, Tex.
		Troop C		Inactive.
1937	Jan. 1 to May 31	Squadron less Troop C		Fort McIntosh, Tex.
		Troop C		Inactive.
	June	Squadron less Troop C	1	Fort McIntosh, Tex.
			2–11	Practice march.
			12–30	Fort McIntosh, Tex.
		Troop C		Inactive.
	July 1 to Aug. 31	Squadron less Troop C		Fort McIntosh, Tex.
		Troop C		Inactive.
	September	Squadron less Troops B and C	1–30	Fort McIntosh, Tex.
		Troop B	1– 7	Do.
			8	En route to Camp Bullis, Tex.
			9–30	Camp Bullis, Tex. (with test units for proposed Infantry Division).
		Troop C		Inactive.
	October	Squadron less Troops B and C	1–31	Fort McIntosh, Tex.
		Troop B	1–31	Camp Bullis, Tex.
		Troop C		Inactive.
	November	Squadron less Troops B and C	1–30	Fort McIntosh, Tex.
		Troop B	1–20	Camp Bullis, Tex.
			21–30	Fort McIntosh, Tex.
		Troop C	1–30	Do.
	December	Squadron less Troop C	1–31	Do.
		Troop C		Inactive.

EIGHTH ENGINEER TRAIN (MOUNTED)

The Eighth Engineer Train was organized under the provisions of the Act of Congress approved May 18, 1917, at Camp Stewart, Fort Bliss, Tex., on August 8, 1917, pursuant to First Endorsement A. G. O. 2605788, dated June 9, 1917.

Year	Month	Element	Dates	Station
1917	August	Train	8-31	Camp Stewart, Fort Bliss, Tex.
	September	do	1-30	Do.
	October	do	1-29	Do.
			30	Camp Courchesne, N. Mex.
	November	do	1-29	Do.
			30	Camp Baker, Fort Bliss, Tex.
1918	Dec. 1 to May 31	do		Do.
	June	do	1-23	Do.
			24-30	March to Las Cruces, N. Mex., and return to Camp Baker.
	July	do	1-14	Camp Baker, Fcrt Bliss, Tex.
			15-22	En route to Camp Head Springs, Mescalero, N. Mex.
			23-31	Camp Head Springs, Mescalero, N. Mex.
	August	do	1-14	Do.
			15-22	En route to Camp Baker, Fort Bliss, Tex.
		do	23-31	Camp Baker, Fort Bliss, Tex.
1919	Sept. 1 to July 31	do		Do.

NOTE.—Engaged in operations against Villista forces in Mexico June 15 and 16, 1919.

Year	Month	Element	Dates	Station
	August	Train	1-16	Camp Baker, Fort Bliss, Tex.
			17-21	En route to Camp Wagner, Cloudcroft, N. Mex.
			22-31	Camp Wagner, Cloudcroft, N. Mex.
	September	do	1-15	Do.
			16-19	En route to Camp Baker, Fort Bliss, Tex.
			20-30	Camp Baker, Fort Bliss, Tex.
1920	Oct. 1 to Feb. 29	do		Do.
	Mar. 1 to June 30	do		Fort Bliss, Tex.
	July	do	1-20	Do.
			21-27	En route to Camp Dickman, Elephant Butte Dam, N. Mex.
			28-31	Camp Dickman, Elephant Butte Dam, N. Mex.
	August	do	1- 3	Do.
			4-10	En route to Fort Bliss, Tex.
			11-31	Fort Bliss, Tex.
1921	Sept. 1 to May 31	do		Do.
	June	do	1-15	Do.

NOTE.—The 8th Engineer Train was demobilized June 15, 1921; officers and enlisted men transferred to 8th Engineers (Mounted) and the final return rendered same date per authority 2d endorsement, Headquarters 8th Corps Area, dated June 6, 1921.

NINTH ENGINEERS (SQUADRON)

Organized under the provisions of the Act of Congress approved June 3, 1916, as the Second Battalion of Mounted Engineers from Company A, First Battalion of Mounted Engineers, at Camp Newton D. Baker, El Paso, Tex., May 21, 1917, pursuant to War Department G. O. No. 62, 1917, and to G. O. No. 6, Headquarters Second Regiment of Engineers, dated May 21, 1917. Redesignated as Ninth Engineers (Mounted) per G. O. No. 48, Headquarters Southern Department, dated July 29, 1917, pursuant to instructions from the War Department dated July 10, 1917.

Year	Month	Element	Dates	Station
1917	May	Battalion	21–23	Camp Newton D. Baker, El Paso, Tex.
			24–31	Camp Stewart, Fort Bliss, Tex.
	June 1 to Sept. 30	do	--------	Do.
	October	do	1–29	Camp Courchesne, El Paso, Tex.
			30	En route to Mescalero Indian Reservation, N. Mex.
	November	do	1– 6	Do.
			7–22	Mescalero Indian Reservation, N. Mex.
			23–28	En route to Camp Courchesne, El Paso, Tex.
			29–31	Camp Courchesne, El Paso, Tex.
1918	Dec. 1 to May 31	do	--------	Do.
	June	do	1– 3	Do.
			4–11	En route to Camp Head Springs, Mescalero, N. Mex.
			12–30	Camp Head Springs, Mescalero, N. Mex.
	July	do	1– 4	Do.
			5–11	En route to Camp Courchesne, El Paso, Tex.
			12–31	Camp Courchesne, El Paso, Tex.
	Aug. 1 to Dec. 31	do	--------	Do.
1919	January	do	1–14	Do.
			15–18	En route to Camp Cody, Deming, N. Mex.
			19–31	Camp Cody, Deming, N. Mex.
	February	do	1–10	Do.
			11–14	En route to Camp Courchesne, El Paso, Tex.
			15–17	Camp Courchesne, El Paso, Tex.
			18–21	En route to Camp Cody, Deming, N. Mex.
			22–28	Camp Cody, Deming, N. Mex.
	March	do	1–31	Do.
	April	do	1–13	Do.
			14–17	En route to Camp Courchesne, El Paso, Tex.
			18–30	Camp Courchesne, El Paso, Tex.
	May	do	1–31	Do.
	June	do	1–14	Do.
			15–16	Engaged in operations against Villista forces in Mexico.
			17–30	Camp Courchesne, El Paso, Tex.
	July	do	1–31	Do.
	August	do	1–15	Do.
			16–21	En route to Camp Wagner, Cloudcroft, N. Mex.
			22–31	Camp Wagner, Cloudcroft, N Mex.
	September	do	1–15	Do.
			16–19	En route to Camp Courchesne, El Paso, Tex.
			20–30	Camp Courchesne, El Paso, Tex.
1920	Oct. 1 to Mar. 31	do	--------	Do.
	April	do	1–14	Do.
			15–30	En route to Camp Travis, Tex. (by marching).

Year	Month	Element	Dates	Station
1920	May	Battalion	1–22	En route to Camp Travis, Tex.
			23–31	Camp Travis, Tex.
	June 1 to Aug. 31	do		Do.
	September	do	1– 4	Do.
			5–30	Camp Bullis, Texas.
	October	do	1–31	Do.
	November	do	1–14	Do.
			15–30	Camp Travis, Tex.
	December	Battalion less Company C	1–16	Do.
			17	En route to Fort Sam Houston, Tex.
			18–31	Fort Sam Houston, Tex.
		Company C	1–17	Camp Travis, Tex.
			18–31	En route to Sam Fordyce, Tex.
1921	January	Battalion less Company C	1–31	Fort Sam Houston, Tex.
		Company C	1–31	Sam Fordyce, Tex.
	February	Battalion less Companies A and C.	1–28	Fort Sam Houston. Tex.
		Company A	1–28	Camp Bullis, Tex.
		Company C	1–28	Sam Fordyce, Tex.
	March	Battalion less Companies A, B, and C.	1–31	Fort Sam Houston, Tex.
		Company A	1–13	Camp Bullis, Tex.
			14–31	Fort Sam Houston, Tex.
		Company B	1– 5	Camp Bullis, Tex.
			6–31	Fort Sam Houston, Tex.
		Company C	1–31	Sam Fordyce, Tex.
	Apr. 1 to May 31	Battalion less Company C		Fort Sam Houston, Tex.
		Company C		Sam Fordyce, Tex.
	June	Battalion less Company C	1–30	Camp Bullis, Tex.
		Company C	1–30	Fort Ringgcld, Tex.
	July	Battalion less Company C	1–16	Camp Bullis, Tex.
			17–31	Fort Sam Houston, Tex.
		Company C	1–31	Sam Fordyce, Tex.
	August	Battalion less Company C	1–31	Fort Sam Houston, Tex.
		Company C	1–31	Sam Fordyce, Tex.
	September	Battalion less Companies A and C.	1–30	Fort Sam Houston, Tex.
		Company A	1–15	Do.
			16–30	En route by marching to Fort Riley, Kans.
		Company C	1–25	Sam Fordyce, Tex.
			26–30	En route to Fort Sam Houston, Tex.
	October	Headquarters and Service Platoon and Companies B and C.	1	Placed on inactive list at Fort Sam Houston, Tex.
				Company C made inactive while en route to Fort Sam Houston, Tex.
		Company A	1–29	En route to Fort Riley, Kans.
			30–31	Fort Riley, Kans.
1927	Nov. 1 to Aug. 31	do		Do.
		Battalion less Company A		Inactive.
	September	Company A	1– 8	Practice march.
			9–26	Fort Riley, Kans.
			27–30	Clay Center, Kans.
		Battalion less Company A		Inactive.
1929	Oct. 1 to Sept. 30	Company A		Fort Riley, Kans.
		Battalion less Company A		Inactive.
	October	Company A	1– 3	Fort Riley, Kans.
			4–24	Practice march.
			25–31	Fort Riley, Kans.
		Battalion less Company A		Inactive.
1930	Nov. 1 to Mar. 31	Company A		Fort Riley, Kans.
		Battalion less Company A		Inactive.
	April	Company A	1–18	Fort Riley, Kans.
		1st Platoon Troop A	19–30	Do.

NOTE.—9th Engineers (Mounted) redesignated 9th Engineer Squadron and personnel of Company A, 9th Engineers (Mounted) transferred to 1st Platoon, Troop A, 9th Engineer Squadron, Apr. 19, 1930. (Letter A. G. 320.2 Engrs. (1-31-30) Misc. (Returns), dated Apr. 8, 1930.

	May 1 to Aug. 31	1st Platoon Troop A		Fort Riley, Kans.
		Squadron less 1st Platoon Troop A.		Inactive.
	September	1st Platoon Troop A	1–14	Fort Riley, Kans.
			15–26	Practice march.
			27–30	Fort Riley, Kans.
		Squadron less 1st Platoon, Troop A.		Inactive.
1931	Oct. 1 to June 30	1st Platoon, Troop A		Fort Riley, Kans.
		Squadron less 1st Platoon, Troop A.		Inactive.

Year	Month	Element	Dates	Station
1931	July 1 to Aug. 31	Troop A (less 1 platoon)		Fort Riley, Kans.
		Squadron less Troop A (less 1 platoon).[19]		Inactive.
1931	September	Troop A (less 1 platoon)	1-23	Fort Riley, Kans.
			24-30	On practice march.
		Squadron less Troop A (less 1 platoon).		Inactive.
	October	Troop A (less 1 platoon)	1-14	Practice march.
			15-31	Fort Riley, Kans.
		Squadron less Troop A (less 1 platoon).		Inactive.
	Nov. 1	Troop A (less 1 platoon)		Fort Riley, Kans.
	to	Squadron less Troop A (less 1 platoon).		Inactive.
1934	Sept. 30			
	October	Troop A (less 1 platoon)	1- 9	Fort Riley, Kans.
			10-13	Practice march.
			14-31	Fort Riley, Kans.
		Squadron less Troop A (less 1 platoon).		Inactive.
	Nov. 1	Troop A (less 1 platoon)		Fort Riley, Kans.
	to	Squadron less Troop A (less 1 platoon).		Inactive.
1935	Nov. 30			
	Dec. 1	Troop A		Fort Riley, Kans.
	to	Squadron less Troop A		Inactive.
1936	May 31			
	NOTE.—Increased to a full troop under provisions of increasing the enlisted strength of the Army from 118,000 to 165,000.			
	June	Troop A	1- 5	Fort Riley, Kans.
			6-21	Field maneuvers.
			22-30	Fort Riley, Kans.
		Squadron less Troop A		Inactive.
	July 1 to Dec. 31	Troop A		Fort Riley, Kans.
		Squadron less Troop A		Inactive.
1937	Jan. 1 to Dec. 31	Troop A		Fort Riley, Kans.
		Squadron less Troop A		Inactive.

---

[19] Designation changed from 1st Platoon, Troop A, 9th Engineers Squadron to Troop A (less 1 platoon), letter A. G. 320.2 dated July 22, 1931.

NINTH ENGINEER TRAIN (MOUNTED)

The Ninth Engineer Train was organized under the provisions of the Act of Congress approved June 3, 1916, as the First Engineer Train, Cavalry, at Camp Stewart, El Paso, Tex., on June 21, 1917, pursuant to letter A. G. 2416322-A dated March 21, 1917, and S. O. No. 93, Southern Department, 1917. Designation changed from First Engineer Train, Cavalry, to Ninth Engineer Train per G. O. No. 48, Headquarters Southern Department, dated July 29, 1917, issued pursuant to instructions from the War Department dated July 10, 1917.

Year	Month	Element	Dates	Station
1917	June	9th Engineer Train	21-30	Camp Stewart, El Paso, Tex.
	July 1 to Sept. 30	do		Do.
	October	do	1-24	Do.
			25-31	Courchesne Bridge, El Paso, Tex.
1918	Nov. 1 to May 31	do		Do.
	June	do	1- 3	Do.
			4-11	En route to Camp Head Springs, Mescalero Indian Reservation, N. Mex.
			12-28	Camp Head Springs, N. Mex.
			29	En route to Cloudcroft, N. Mex.
			30	En route to Camp Head Springs, N. Mex.
	July	do	1- 4	Mescalero Indian Reservation, Camp Head Springs, N. Mex.
			5-11	En route to Courchesne Bridge, El Paso, Tex.
			12-31	Courchesne Bridge, El Paso, Tex.
	Aug. 1 to Oct. 31	do		Do.
	Nov. 1 to Dec. 31	do		Do.
1919	January	do	1-14	Do.
			15-18	En route to Camp Cody, Deming, New Mexico.
			19-31	Camp Cody, Deming, N. Mex.
	February	do	1-10	Do.
			11-14	En route to Camp Courchesne, El Paso, Tex.
			15-17	Camp Courchesne, El Paso, Tex.
			18-21	En route to Camp Cody, Deming, N. Mex.
			22-28	Camp Cody, Deming, N. Mex.
	March	do	1-31	Do.
	April	do	1-13	Do.
			14-17	En route to Camp Courchesne, El Paso, Tex.
			18-30	Camp Courchesne, El Paso, Tex.
	May	do	1-31	Do.
	June	do	1-14	Do.
			15-16	Engaged in operations against Villista forces in Mexico.
			17-30	Camp Courchesne, El Paso. Tex.
	July	do	1-10	Camp Courchesne, N. Mex.
			11-16	En route to Camp Wagner, Cloudcroft, N. Mex.
			17-31	Camp Wagner, Cloudcroft, N. Mex.
	August	do	1-15	Do.
			16-19	En route to Camp Courchesne, El Paso, Tex.
			20-31	Camp Courchesne, El Paso, Tex.

Year	Month	Element	Dates	Station
1919 1920	Sept. 1 to Mar. 31	9th Engineer Train	--------	Camp Courchesne, El Paso,
	April	do	1-14	Do.
			15-30	En route to Camp Travis, Tex.
	May	do	1-22	Do.
			23-31	Camp Travis, Tex.
	June 1 to Nov. 30	do	--------	Do.
	December	do	1-16	Do.
			17	En route to Fort Sam Houston, Tex.
			18-31	Fort Sam Houston, Tex.
1921	January	do	1-31	Do.

NOTE.—9th Engineer train disbanded pursuant to telegram from Chief of Engineers dated Jan. 30, 1921. Personnel transferred to 9th Engineers (Mounted), effective Feb. 1, 1921.

ELEVENTH ENGINEERS (RAILWAY)

The World War Eleventh Engineers (Railway) was authorized for organization as the First Reserve Engineers pursuant to letter from the Adjutant General to the Chief of Engineers dated March 14, 1917 (E. D. 101760/176), under the provisions of section 55, Act of Congress approved June 3, 1916 (Bul. W. D. No. 16, 1916). The First Reserve Engineers was ordered into active service at New York City (Fort Totten) during May 1917, under authority of G. O. No. 61, War Department, 1917. In accordance with telegram from the Adjutant General dated May 14, 1917, Lt. Col. Charles H. McKinstry was assigned to command and directed to expedite organization in the vicinity of New York City. The designation of the First Reserve Engineers was changed to First Engineers, National Army, per G. O. No. 74, War Department, dated June 9, 1917, and redesignated Eleventh Engineers (Railway) pursuant to letter from the Adjutant General dated July 10, 1917.

Year	Month	Element	Dates	Station
1917	May	Headquarters Detachment	*18-31	Room 811, Army Building, New York City.
		Company A	*14-31	Fort Totten, N. Y.
		Company B	*29-31	Do.
		Company C	*30-31	Do.
		Company D	*31	Do.
	June	Regiment less Companies E and F.	1-30	Do.
		Company E	*1-30	Do.
		Company F	*2-30	Do.
	July	Regiment	1-13	Do.
			14-27	Aboard R. M. S. *Carpathia* en route to Plymouth, England. (Arrived in camp at Oxney, Bordon, England, 27th.)
			28-31	Oxney Camp, Bordon, England. (Regiment reviewed by His Majesty King George, 28th.)
	August	do	1-5	Oxney Camp, Bordon, England.
			6-7	En route to Boulogne, France. (Arrived at Folkestone, England, 3 p. m. 6th, and boarded steamer *Princess Victoria* same day.)
			8-31	With American Expeditionary Forces in France.
  1919	Sept. 1 to Mar. 31	do		Do.
	April	Regiment less Company C	1-14	Do.
			15	Boarded U. S. S. *Chicago*.
			16-26	Aboard U. S. S. *Chicago* en route from Bordeaux to pier No. 84, New York City.
			27	Debarked and en route to Camp Mills, N. Y.
			28-30	Camp Mills, N. Y.
		Company C	1-14	With American Expeditionary Forces in France.
			15-23	Aboard U. S. S. *Santa Teresa* en route from Bordeaux, France, to Hoboken, N. J. (Arrived Camp Mills, N. Y., 23d.)
			24-30	Camp Mills, N. Y.
	May	Regiment	1	Do.
			2	En route to Camp Upton, N. Y.
			3-5	Camp Upton, N. Y.
			6	Demobilized at Camp Upton, N.Y.

NOTE.—Under authority of letter A. G. 320.2 (4-1-32) Misc. (Ret.)-C dated Apr. 26, 1932 (C. E. file 320.2 (Engrs., Corps of) 740) the 11th Engineers (Railway) was reconstituted and consolidated with the 11th Engineers (Combat).

---

*Date of mobilization.

ELEVENTH ENGINEERS (COMBAT)

In compliance with letter from The Adjutant General of the Army to the Commanding General, Panama Canal Department, dated November 4, 1920, file 322-1 P. C. D. (Misc. Div.) and G. O. No. 48, Headquarters, P. C. D., November 18, 1920, the personnel and equipment of the Second Battalion, Third Engineers (less Company D) were transferred to the Eleventh Engineers. The Eleventh Engineers was organized November 20, 1920, with station at Corozal, Panama Canal Zone. Regimental Headquarters, and Companies A, B, and C of the First Battalion were organized but due to lack of sufficient personnel Companies D, E, and F were not organized.

Year	Month	Element	Dates	Station
1920	November	Regiment less 2d Battalion	20-30	Corozal, Canal Zone.
1921	Dec. 1 to June 30	do		Do.
	July	Regiment less 2d Battalion and Company C.	1-31	Do.
		Company C	1-18	Do.
			19-31	Taboga Island, Panama.
1922	Aug. 1 to June 30	Regiment less 2d Battalion		Corozal, Canal Zone.
	July	do	1-31	Do.
		Company D (organized 19th)	19-31	Do.
		Companies E and F (organized 26th).	26-31	Do.
	Aug. 1 to Dec. 31	Regiment		Do.
1923	January	Regiment less Companies B, C, D, and E.	1-31	Do.
		Company B	1-15	Do.
			16-31	Campana, Panama.
		Company C	1- 7	Corozal, Canal Zone.
			8-15	Wilson's Landing, Bayano River, Panama.
			16-31	Chepo, Panama.
		Company D	1-11	Corozal, Canal Zone.
			12-31	Pueblo Cermeno, Panama.
		Company E	1-10	Corozal, Canal Zone.
			11	En route to Balboa, Canal Zone.
			12-31	Chepo, Panama.
	February	Regiment less Companies B, C, D, and E.	1-28	Corozal, Canal Zone.
		Company B	1-28	Campana, Panama.
		Companies C and E	1-28	Chepo, Panama.
		Company D	1-28	Pueblo Cermeno, Panama.
	March	Regiment less Companies A, B, C, D, and E.	1-31	Corozal, Canal Zone.
		Company A	1-14	Tacoma, Panama.
			15-31	Corozal, Canal Zone.
		Company B	1-31	Campana, Panama.
		Companies C and E	1-31	Chepo, Panama.
		Company D	1-31	Pueblo Cermeno, Panama.
	April	Regiment less Companies B, C, D, and E.	1-30	Corozal, Canal Zone.
		Company B	1-30	Campana, Panama.
		Companies C and E	1-30	Chepo, Panama.
		Company D	1-30	Pueblo Cermeno, Panama.
	May	Regiment less Companies B, C, D, and E.	1-31	Corozal, Canal Zone.
		Company B	1-26	Campana, Panama.
			27-31	Corozal, Canal Zone.
		Company C	1-29	Chepo, Panama.
			30-31	Corozal, Canal Zone.
		Company D	1-31	Pueblo Cermeno, Panama.
		Company E	1-24	Chepo, Panama.
			25-31	Corozal, Canal Zone.

Year	Month	Element	Dates	Station
1923	June	Regiment less Company D	1–30	Carozal, Canal Zone.
		Company D	1–14	Pueblo Cermeno, Panama.
			15–30	Corozal, Canal Zone.
	July 1 to Nov. 30	Regiment		Do.
	December	Regiment less Company A	1–31	Do.
		Company A	1–26	Do.
			27–31	France Field, Canal Zone.
1924	January	Regiment less Companies B, C, D, and E.	1–31	Corozal, Canal Zone.
		Company B	1–15	Do.
			16–31	Bejuco, Panama.
		Company C	1–10	Corozal, Canal Zone.
			11–31	Chame, Panama.
		Company D	1–21	Corozal, Canal Zone.
			22–31	Libano, Panama.
		Company E	1–18	Corozal, Canal Zone.
			19–31	Camp at Rio Tigre, Panama.
	Feb. 1 to Apr. 30	Regiment less Companies B, C, D, and E.		Corozal, Canal Zone.
		Company B		Bejuco, Panama.
		Company C		Chame, Panama.
		Company D		Libano, Panama.
		Company E		Camp at Rio Tigre, Panama.
	May	Regiment less Companies B, C, D, and E.	1–31	Corozal, Canal Zone.
		Company B	1– 2	Bejuco, Panama.
			3–31	Corozal, Canal Zone.
		Company C	1– 8	Chame, Panama.
			9–31	Corozal, Canal Zone.
		Company D	1–19	Libano, Panama.
			20–31	Corozal, Canal Zone.
		Company E	1–20	Camp at Rio Tigre, Panama.
			21–31	Corozal, Canal Zone.
	June 1 to Dec. 31	Regiment		Do.
1925	January	Regiment less Companies B, C, D, and E.	1–31	Do.
		Company B	1–12	Do.
			13–31	Camp on Rio Pescado, Panama.
		Company C	1– 5	Corozal, Canal Zone.
			6–31	Gamboa, Canal Zone.
		Company D	1–19	Corozal, Canal Zone.
			20–31	Forsythe's Camp, Canal Zone.
		Company E	1–13	Corozal, Canal Zone.
			14–31	Camp Tocumen, Panama.
	Feb. 1 to Mar. 31	Regiment less Companies B, C, D, and E.		Corozal, Canal Zone.
		Company B		Camp on Rio Pescado, Panama.
		Company C		Gamboa, Canal Zone.
		Company D		Forsythe's Camp, Canal Zone.
		Company E		Camp Tocumen, Panama.
	April	Regiment less Companies B, C, D, and E.	1–30	Corozal, Canal Zone.
		Company B	1–29	Camp on Rio Pescado, Panama.
			30	Corozal, Canal Zone.
		Company C	1– 8	Gamboa, Canal Zone.
			9–30	Empire, Canal Zone.
		Company D	1–30	Forsythe's Camp, Canal Zone.
		Company E	1– 9	Camp Tocumen, Panama.
			10–19	Chillibre, Panama.
			20–30	Corozal, Canal Zone.
	May	Regiment less Companies C and D.	1–31	Do.
		Company C	1– 5	Empire, Canal Zone.
			6–31	Corozal, Canal Zone.
		Company D	1– 3	Forsythe's Camp, Canal Zone.
			4–31	Corozal, Canal Zone.
	June 1 to Dec. 31	Regiment		Do.
1926	January	Regiment less Companies B, C, and E.	1–31	Do.
		Company B	1– 3	Do.
			4–31	Cuipo, Panama.
		Company C	1– 3	Corozal, Canal Zone.
			4–31	Frijoles, Canal Zone.
		Company E	1– 3	Corozal, Canal Zone.
			4–31	Porto Bello, Panama.
	Feb. 1 to Mar. 31	Regiment less Companies B, C, and E.		Corozal, Canal Zone.
		Company B		Cuipo, Panama.
		Company C		Frijoles, Canal Zone.
		Company E		Porto Bello, Panama.
	April	Regiment less Companies B, C, and E.	1–30	Corozal, Canal Zone.
		Company B	1–30	Cuipo, Panama.
		Company C	1–30	Frijoles, Canal Zone.
		Company E	1–13	Porto Bello, Panama.
			14–30	Nombre de Dios, Panama.

Year	Month	Element	Dates	Station
1926	May	Regiment less Companies B, C, and E.	1-31	Corozal, Canal Zone.
		Company B	1-21	Rio Lagarto, Panama.
			22-31	Corozal, Canal Zone.
		Company C	1-13	Frijoles, Canal Zone.
			14-31	Corozal, Canal Zone.
		Company E	1-20	Nombre de Dios, Panama.
			21-31	Corozal, Canal Zone.
	June 1 to Dec. 31	Regiment		Do.
1927	January	Regiment less Companies B, C, E.	1-31	Do.
		Company B	1-13	Do.
			14-31	Cuipo, Panama.
		Company C	1-13	Corozal, Canal Zone.
			14-31	Santa Rosa, Panama.
		Company E	1-13	Corozal, Canal Zone.
			14-31	Nombre de Dios, Panama.
	Feb. 1 to Mar. 31	Regiment less Companies B, C, E.		Corozal, Canal Zone.
		Company B		Cuipo, Panama.
		Company C		Santa Rosa, Panama.
		Company E		Nombre de Dios, Panama.
	April	Regiment less Companies B, C, E.	1-30	Corozal, Canal Zone.
		Company B	1-28	Cuipo, Panama.
			29-30	Corozal, Canal Zone.
		Company C	1-28	Santa Rosa, Panama.
			29-30	Corozal, Canal Zone.
		Company E	1-29	Nombre de Dios, Panama.
			30	Corozal, Canal Zone.
	May 1 to July 31	Regiment		Do.

NOTE.—Regimental Headquarters and Band established as a unit separate from Headquarters and Service Company, 11th Engineers, per letter A. G. 322.94 (5-4-27) Misc. (Ret.)-C, War Department, June 22, 1927, on July 1, 1927. This entailed the discontinuance of Headquarters, 11th Engineers as such and consolidating it with the Band in the newly formed Unit Regimental Headquarters and Band, 11th Engineers.

Year	Month	Element	Dates	Station
	August	Regiment less Companies B and F.	1-31	Corozal, Canal Zone.
		Companies B and F	1-21	Do.
			22-31	Camp Gaillard, Canal Zone.
	September	Regiment less Companies B and F.	1-30	Corozal, Canal Zone.
		Companies B and F	1-30	Camp Gaillard, Canal Zone.
	October	Regiment less Companies B and F.	1-31	Corozal, Canal Zone.
		Companies B and F	1- 5	Camp Gaillard, Canal Zone.
			6-31	Corozal, Canal Zone.
	Nov. 1 to Dec 31	Regiment		Do.
1928	January	Regiment less Companies B and C.	1-31	Do.
		Company B	1- 8	Do.
			9-31	San Carlos, Panama.
		Company C	1-10	Corozal, Canal Zone.
			11-31	Old San Juan, Panama.
	February	Regiment less Companies B and C.	1-29	Corozal, Canal Zone.
		Company B	1-21	San Carlos, Panama.
			22-29	Anton, Panama.
		Company C	1-29	Old San Juan, Panama.
	March	Regiment less Companies B and C.	1- 4	Corozal, Canal Zone.
			5-28	Maneuvers.
			29-31	Corozal, Canal Zone.
		Company B	1-26	Anton, Panama.
			27-31	Aquadulce, Panama.
		Company C	1- 6	Old San Juan, Panama.
			7-24	Corozal, Canal Zone.
			25-28	Maneuvers.
			29-31	Corozal, Canal Zone.
	April	Regiment less Company B	1-30	Do.
		Company B	1-16	Aquadulce, Panama.
			17-30	Corozal, Canal Zone.
	May 1 to Dec 31	Regiment		Do.
1929	January	Regiment less Company F	1-21	Do.
			22-27	Camp at Miraflores, East, Canal Zone.
			28-31	Corozal, Canal Zone.
		Company F	1-21	Do.
			22-27	Camp at Miraflores, East, Canal Zone.
			28-31	Chorrer, Panama.

Year	Month	Element	Dates	Station
1929	February	Regiment	1-16	Maneuvers.
			17-20	Corozal, Canal Zone.
		Regiment less 1st Battalion	21-28	San Carlos, Panama.
		1st Battalion	21-28	Escoval, Panama.
	March	Regiment less 1st and 2d Battalions.	1-31	Corozal, Canal Zone.
		1st Battalion	1-31	Escoval, Panama.
		2d Battalion	1-31	San Carlos, Panama.
	April	Regiment less 1st and 2d Battalions.	1-30	Corozal, Canal Zone.
		Headquarter 1st Battalion and Company B.	1-26	Escoval, Panama.
			27-30	Corozal, Canal Zone.
		Company A	1-15	Escoval, Panama.
			16-30	France Field, Canal Zone.
		Company C	1-30	Escoval, Panama.
		2d Battalion	1-27	San Carlos, Panama.
			28-30	Corozal, Canal Zone.
	May	Regiment less 1st Battalion and Band.	1-21	San Carlos, Panama.
			22-31	Corozal, Canal Zone.
		1st Battalion	1-31	Escoval, Panama.
		Band	1-31	Corozal, Canal Zone.
	June	Regiment	1-30	Do.
	July	Regiment less 1st Battalion	1-31	Do.
		1st Battalion	1-14	Do.
			15-31	Fort Clayton, Canal Zone.
	August	Regiment less 1st and 2d Battalions.	1-31	Corozal, Canal Zone.
		1st Battalion	1-14	Fort Clayton, Canal Zone.
			15-31	Corozal, Canal Zone.
		2d Battalion less Company F	1-14	Do.
			15-31	Fort Clayton, Canal Zone.
		Company F	1-26	Corozal, Canal Zone.
			27-31	With Nicaraguan Survey Battalion.

NOTE.—Company F assigned to Nicaraguan Survey Battalion as Company "C" of that Battalion without losing identity 370 (Nicaragua Canal) 68.

Year	Month	Element	Dates	Station
	September	Regiment less 2d Battalion	1-30	Corozal, Canal Zone.
		2d Battalion less Company F	1-21	Fort Clayton, Canal Zone.
			22-30	Corozal, Canal Zone.
		Company F	1-30	With Nicaraguan Survey Battalion.
	October	Regiment less Companies D and F.	1-31	Corozal, Canal Zone.
		Company D	1- 5	Do.
			6-31	San Lorenzo, Panama.
		Company F	1-31	With Nicaraguan Survey Battalion.
	November	Regiment less Companies D and F.	1-30	Corozal, Canal Zone.
		Company D	1-29	San Lorenzo, Panama.
			30	Corozal, Canal Zone.
		Company F	1-30	With Nicaraguan Survey Battalion.
	December	Regiment less Company F	1-31	Corozal, Canal Zone.
		Company F	1-31	With Nicaraguan Survey Battalion.
1930	January	Regiment less Companies A, B, D, E, F.	1-31	Corozal, Canal Zone.
		Company A	1- 7	Do.
			8-21	Camp Velasquez, Canal Zone.
			22-31	Chorrera, Panama.
		Company B	1	Corozal, Canal Zone.
			2-31	Camp Velasquez, Canal Zone.
		Company D	1	Corozal, Canal Zone.
			2-31	Capira, Panama.
		Company E	1	Corozal, Canal Zone.
			2-31	Camp Young, Canal Zone.
		Company F	1-31	With Nicaraguan Survey Battalion.
	February	Regiment less Companies A, B, D, E, F.	1-28	Corozal, Canal Zone.
		Company A	1- 9	Chorrera, Panama.
			10-28	Bruja Trail Junction 51.
		Company B	1-28	Camp Velasquez, Canal Zone.
		Company D	1-28	Capira, Panama.
		Company E	1-28	Camp Young, Canal Zone.
		Company F	1-28	With Nicaraguan Survey Battalion.
	March	Regiment less Companies A, B, D, E, F.	1-31	Corozal, Canal Zone.

Year	Month	Element	Dates	Station
1930	March	Company A	1- 2	Bruja Trail Junction 51.
			3- 9	Corozal, Canal Zone.
			10-31	Camp Gatun, Canal Zone.
		Company B	1- 9	Corozal, Canal Zone.
			10-31	Camp Gatun, Canal Zone.
		Company D	1-31	Capira, Panama.
		Company E	1-31	Camp Young, Canal Zone.
		Company F	1-31	With Nicaraguan Survey Battalion.
	April	Regiment less Companies A, B, D, E, F.	1-30	Corozal, Canal Zone.
		Company A	1-30	Camp Gatun, Canal Zone.
		Company B	1-24	Camp Young, Canal Zone.
			25-26	Corozal, Canal Zone.
			27-30	Camp Gatun, Canal Zone.
		Company D	1-27	Capira, Panama.
			28-30	Corozal, Canal Zone.
		Company E	1-18	Camp Young, Canal Zone.
			19-30	Corozal, Canal Zone.
		Company F	1-30	With Nicaraguan Survey Battalion.
	May	Regiment less Companies A, B, and F.	1-31	Corozal, Canal Zone.
		Companies A and B	1-29	Camp Gatun, Canal Zone.
			30-31	Corozal, Canal Zone.
		Company F	1-31	With Nicaraguan Survey Battalion.
	June	Regiment less Company F	1-30	Corozal, Canal Zone.
		Company F	1-30	With Nicaraguan Survey Battalion.
	July	Regiment less 2d Battalion	1-30	Corozal, Canal Zone.
		2d Battalion less Company F.	1-14	Do.
			15-30	Fort Clayton, Canal Zone.
		Company F	1-30	With Nicaraguan Survey Battalion.
	August	Regiment less 1st and 2d Battalions.	1-31	Corozal, Canal Zone.
		1st Battalion	1- 3	Do.
			4-31	Fort Clayton, Canal Zone.
		2d Battalion less Company F	1- 2	Do.
			3-31	Corozal, Canal Zone.
		Company F	1-31	With Nicaraguan Survey Battalion.
	September	Regiment less 1st Battalion and Company F.	1-30	Corozal, Canal Zone.
		1st Battalion	1- 9	Fort Clayton, Canal Zone.
			10-30	Corozal, Canal Zone.
		Company F	1-30	With Nicaraguan Survey Battalion.
	Oct. 1 to Nov. 30	Regiment less Company F		Corozal, Canal Zone.
		Company F		With Nicaraguan Survey Battalion.
	December	Regiment less Company F	1-31	Corozal, Canal Zone.
		Company F	1-20	With Nicaraguan Survey Battalion.
			21-31	Corozal, Canal Zone (rejoined, 21st).
1931	January	Regiment less Companies A and B.	1-31	Corozal, Canal Zone.
		Company A	1	Do.
			2-31	Campana, Panama.
		Company B	1	Corozal, Canal Zone.
			2-31	Upper Chagres, Panama.
	February	Regiment less 2d Battalion and Companies A and B.	1-28	Corozal, Canal Zone.
		2d Battalion	1-14	Maneuvers.
			15-28	Corozal, Canal Zone.
		Company A	1-28	Campana, Panama.
		Company B	1-28	Upper Chagres, Panama.
	March	Regiment less Companies A and B.	1-31	Corozal, Canal Zone.
		Company A	1-31	Campana, Panama.
		Company B	1-31	Upper Chagres, Panama.
	April	Regiment less Companies A and B.	1-30	Corozal, Canal Zone.
		Company A	1-28	Campana, Panama.
			29-30	Corozal, Canal Zone.
		Company B	1- 4	Upper Chagres, Panama.
			5-30	Corozal, Canal Zone.
	May 1 to Nov. 30	Regiment		Do.
	December	Regiment less Company E	1-31	Do.
		Company E	1-20	Aquadulce, Panama.
			21-31	Corozal, Canal Zone.

Year	Month	Element	Dates	Station
1932	January	Regiment	1-18	Carozal, Canal Zone.
			19-27	Maneuvers.
			28-31	Corozal, Canal Zone.
	February	Regiment less Companies D, E, and F.	1-29	Do.
		Companies D and F	1-12	Do.
			13-29	Gatun Lake, Canal Zone.
		Company E	1-12	Corozal, Canal Zone.
			13-29	Santiago, Panama.
	March	Regiment less Companies D, E, and F.	1-31	Corozal, Canal Zone.
		Companies D and F	1-31	Gatun Lake, Canal Zone.
		Company E	1-31	Santiago, Panama.
	April	Regiment less Companies D, E, and F.	1-30	Corozal, Canal Zone.
		Companies D and F	1-23	Gatun Lake, Canal Zone.
			24-30	Corozal, Canal Zone.
		Company E	1-23	Santiago, Panama.
			24-30	Corozal, Canal Zone.

NOTE.—Under authority of letter A. G. 320.2 (4-1-32) Misc. (Ret.) C dated Apr. 26, 1932 (C. E. file 320.2 (Engineers, Corps of) 740) the 11th Engineers (Railway) was reconstituted and consolidated with the 11th Engineers (Combat).

	May 1 to Aug. 31	Regiment		Corozal, Canal Zone.
	September	Regiment less Company C	1-30	Do.
		Company C	1-12	Do.
			13-30	Fort Amador, Canal Zone.
	October	Regiment less Company C	1-31	Corozal, Canal Zone.
		Company C	1-22	Fort Amador, Canal Zone.
			23-31	Corozal, Canal Zone.
	November	Regiment less Company E	1-30	Do.
		Company E	1-12	Do.
			13-30	Aquadulce, Panama.
	December	Regiment less Company E	1-31	Corozal, Canal Zone.
		Company E	1-31	Divisa, Panama.
1933	January	Regiment less Companies D, E, and F.	1-31	Corozal, Canal Zone.
		Company D	1-2	Do.
			3-28	Camp Cocle, Panama.
			29-31	Corozal, Canal Zone.
		Company E	1-28	Camp Guarare, Panama.
			29-31	Corozal, Canal Zone.
		Company F	1-2	Do.
			3-28	Camp Windy, Canal Zone.
			29-31	Corozal, Canal Zone.
	February	Regiment less Companies D, E, and F.	1-28	Do.
		Company D	1-27	Do.
			28	Camp Cocle, Canal Zone.
		Company E	1-27	Corozal, Canal Zone.
			28	Camp Guarare, Panama.
		Company F	1-27	Corozal, Canal Zone.
			28	Camp Windy, Panama.
	March	Regiment less Companies D, E, and F.	1-31	Corozal, Canal Zone.
		Company D	1-31	Camp Cocle, Panama.
		Company E	1-31	Camp Guarare, Panama.
		Company F	1-31	Camp Windy, Panama.
	April	Regiment less Companies D, E, and F.	1-30	Corozal, Canal Zone.
		Company D	1-14	Camp Cocle, Canal Zone.
			15-30	Corozal, Canal Zone.
		Company E	1-2	Camp Quarare, Panama.
			3-30	Corozal, Canal Zone.
		Company F	1-14	Camp Windy, Panama.
			15-30	Corozal, Canal Zone.
	May 1 to Dec. 31	Regiment		Do.
1934	January	Regiment less Company E	1-31	Do.
		Company E	1-2	Do.
			3-31	Guarare, Panama.
	February	Regiment less Company E	1-28	Corozal, Canal Zone.
		Company E	1-18	Guarare, Panama.
			19-28	Corozal, Canal Zone.
	March	Regiment less Companies A and C.	1-4	Do.
			5-14	Maneuvers.
			15-18	Corozal, Canal Zone.
			19-27	Encampment, Atlantic side.
			28-31	Corozal, Canal Zone.
		Company A	1-4	Do.
			5-14	Maneuvers.
			15-18	Corozal, Canal Zone.
			19-31	Miraflores & Pedro Miguel Locks.

Year	Month	Element	Dates	Station
1934	March	Company C	1-4	Corozal, Canal **Zone**.
			5-14	Maneuvers.
			15-23	Corozal, Canal **Zone**.
			24-30	Cutting trail, **Madden** Dam to Atlantic side.
			31	Corozal, Canal **Zone**.
1935	Apr 1 to Jan. 31	Regiment	-------	Do.
	February	do	1-10	Do.
			11-16	Maneuvers.
			17-28	Corozal, Canal Zone.
	March	do	1-6	Do.
			7-10	Maneuvers.
			11-31	Corozal, Canal Zone.
	April	do	1-4	Do.
			5-30	Parita Bay Area, **Panama**.
	May	do	1-31	Do.
	June	Headquarters and Service Company and Company A.	1-21	Do.
			22-30	Corozal, Canal Zone.
		Company B	1-14	Parita Bay Area, **Panama**.
			15-30	Corozal, Canal Zone.
		Company C	1-16	Parita Bay Area, **Panama**.
			17-30	Corozal, Canal Zone.
		Company D	1-18	Parita Bay Area, **Panama**.
			19-30	Corozal, Canal Zone.
		Company E and Band	1-19	Parita Bay Area, **Panama**.
			20-30	Corozal, Canal Zone.
		Company F	1-20	Parita Bay Area, **Panama**.
			21-30	Corozal, Canal Zone.
1936	July 1 to Jan. 31	Regiment	-------	Do.
	February	do	1-16	Do.
		Regiment less 2d Battalion	17-21	Maneuvers.
		2d Battalion	17-21	Corozal, Canal Zone.
		Regiment	22-25	Do.
			26-27	Rio Corundu, Canal **Zone**.
			28-29	Corozal, Canal Zone.
	March	do	1-13	Do.
			14-27	Maneuvers.
			28-31	Corozal, Canal Zone.
	Apr. 1 to Dec. 31	do	-------	Do.
1937	January	do	1-31	Do.
	February	do	1-19	Do.
			20-28	Practice march moving in echelons. First echelon returned to *Corozal*. 25th, second, 26th and third, 28th.
	March	do	1-12	Corozal, Canal Zone.
			13-22	Practice march.
			23-31	Corozal, Canal Zone.
	Apr. 1 to May 31	do	-------	Do.
	June	Regiment less Companies E and F.	1-30	Do.
		Companies E and F	1-15	Do.
			16-30	Fort Clayton, Canal Zone.
	July 1 to Dec. 31	Regiment less Companies E and F.	-------	Corozal, Canal Zone.
		Companies E and F	-------	Fort Clayton, Canal Zone.

TWELFTH ENGINEERS (SQUADRON)

The Twelfth Engineer Squadron was organized under the provisions of the Act of Congress approved May 18, 1917, as the Three Hundred Eighteenth Engineers (Sappers) during December 1917 and January and February 1918 at Vancouver Barracks, Wash., pursuant to letter from the Chief of Engineers dated December 24, 1917.

Year	Month	Element	Dates	Station
1917	December	Companies A and B	*31	Vancouver Barracks, Wash.
1918	January	do	1-31	Do.
		Company C	*16-31	Do.
		Company D	*10-31	Do.
		Company E	*23-31	Do.
	February	Headquarters Detachment	*28	Do.
		Companies A, B, C, D, E	1-28	Do.
		Company F	*8-28	Do.
	March	Regiment	1-31	Do.
	April	do	1-21	Do.
			22-29	En route to Camp Merritt, N. J.
			30	Camp Merritt, N. J.
	May	do	1- 5	Do.
			6- 7	Hoboken, N. J.
			8-18	Aboard U. S. S. *America* en route to Brest, France.
			19-31	With American Expeditionary Forces in France.
1919	June 1 to Apr. 30	do		With American Expeditionary Forces in France and Germany.
	May	Regiment less Headquarters Detachment and 2d Battalion.	1-21	American Forces in Germany.
			22	Kaisersesch, Germany.
			23-27	En route to Brest, France.
			28-31	Camp Pontanezen, Brest, France.
		Headquarters Detachment and 2d Battalion.	1-22	American Forces in Germany.
			23	Cochem, Germany.
			24-28	En route to Brest, France.
			29-31	Camp Pontanezen, Brest, France.
	June	Regiment	1- 2	Camp Pontanezen, Brest, France.
			3-11	Aboard U. S. S. *Orizaba* en route to Newport News, Va.
			12-14	Camp Stuart, Va.
			15-17	En route to Camp Grant, Ill.
			18-30	Camp Grant, Ill.
1920	July 1 to Oct. 31	do		Do.
	November	Regiment less headquarters 2d Battalion and Companies D and F.	1-30	Do.
		2d Battalion less Company E	1- 3	Do.
			4	En route to Fort Sheridan, Ill.
			[20] 5-30	Fort Sheridan, Ill.
1921	Dec. 1 to Sept. 7	Regiment [21]		Camp Grant, Ill.
1927	Sept. 8 to Aug. 15	Regiment		Inactive.
1930	Aug. 16 to Jan. 21	Mounted battalion		Do.
1937	Jan. 22 to Dec. 31	Squadron		Do.

---

* Asterisks indicate dates of organization.

[20] Under authority of sec. IV, General Order No. 67, War Department, 1920, the designation of the 318th Sapper Regiment changed to 12th Engineers, effective midnight Nov. 30, 1920.

[21] Regiment placed on the inactive list at Camp Grant, Ill., Sept. 7, 1921. 12th Engineers reassigned to the 6th Division per G. O. No. 10, War Department, 1923.

Relieved from 6th Division and changed to a mounted battalion and assigned to the 3d Cavalry Division, letter A. G. 320.2 (7-5-27) dated Aug. 15, 1927.

Redesignated 12th Squadron Corps of Engineers in conformity with revised T/O 466 W dated Jan. 21, 1930, effective July 1, 1930.

TWELFTH ENGINEER TRAIN (318TH ENGINEER TRAIN)

Under the provisions of the Act of Congress approved May 18, 1917, the Three Hundred and Eighteenth Engineer Train was organized February 23, 1918, at Vancouver Barracks, Wash., pursuant to letter from the Chief of Engineers dated December 24, 1917.

Year	Month	Element	Dates	Station
1918	February	318th Engineer Train	23–28	Vancouver Barracks, Wash.
	March	do	1–31	Do.
	April	do	1–21	Do.
			22–29	En route to Camp Merritt, N. J.
			30	Camp Merrit, N. J.
	May	do	1–5	Do.
			6–7	Hoboken, N. J.
			8–18	Aboard U. S. S. *America* en route to Brest, France.
			19–31	With American Expeditionary Forces in France.
1919	June 1 to Apr. 30	do		With American Expeditionary Forces in France and Germany.
	May	do	1–21	American Forces in Germany.
			22	Kaisersesch, Germany.
			23–27	En route to Brest, France.
			28–31	Camp Pontanezen, Brest, France.
	June	do	1–4	Do.
			5–12	Aboard U. S. S. *Leviathan* en route to Hoboken, N. J.
		do	13–19	Camp Mills, N. Y.
			20–22	En route to Camp Grant, Ill.
			23–30	Camp Grant, Ill.
1920	July 1 to July 31	do		Do.
	August	do	1–3	Do.
			4–31	Field Training, Northern Illinois, Southern Wisconsin.
	September	do	1–8	Do.
			9–30	Camp Grant, Ill.
	Oct. 1 to Dec. 31	do[22]		Do.

---

[22] Under authority of sec. 4, G. O. 64, War Department, 1920, the designation of the 318th Engineers was changed to 12th Engineers, effective midnight Nov. 30, 1920. There is no specific mention of the redesignation of the 318th Engineer Train to the 12th Engineer Train. However, in accordance with Tables of Organization dated Dec. 13, 1920, the 12th Engineer Train was discontinued, the personnel being transferred to the 12th Engineers per G. O. No. 7, Headquarters 6th Division dated Feb. 2, 1921.

THIRTEENTH ENGINEERS (RAILWAY)

The World War Thirteenth Engineers (Railway) was authorized for organization as the Third Reserve Engineers pursuant to letter from the Adjutant General to the Chief of Engineers dated March 14, 1917 (E. D. 101760/176) under the provisions of section 65, Act of Congress approved June 3, 1916 (Bul. No. 16 W. D. 1916). The Third Reserve Engineers were ordered into active service at Chicago, Ill., during May 1917, under authority of G. O. No. 61, War Department 1917. The return of the unit for June 1917 states that no return for May 1917 was rendered, mobilization not having been far enough advanced. During June 1917 the regiment was engaged in mobilization at the Municipal Pier, Chicago, Ill. The designation of the Third Reserve Engineers was changed to Third Engineers, National Army, per G. O. No. 74, War Department, dated June 9, 1917, and redesignated Thirteenth Engineers (Railway) pursuant to letter from the Adjutant General dated July 10, 1917. Under authority of letter A. G. 320.2 (4-1-32) Misc. (Ret) C dated April 26, 1932 (C. E. file 320.2 (Engrs., Corps of) 741) the Thirteenth Engineers (Railway) was reconstituted and consolidated with the Thirteenth Engineers (Combat).

Year	Month	Element	Dates	Station
1917	June	Regiment	1-30	Municipal Pier, Chicago, Ill.
	July	Regiment less 1st Battalion (less Company C).	1-21	Do.
			22	En route to Cunard pier No. 54, New York City. Aboard R. M. S. *Orduna*.
			23-26	En route to Halifax, Nova Scotia.
			27-31	Halifax, Nova Scotia.
		1st Battalion less Company C	1-19	Municipal pier, Chicago, Ill.
			20-21	En route to port of embarkation, Hoboken, N. J.
			22-31	Boarded S. S. *St. Louis* at pier No. 62, and en route to Liverpool via Belfast.
	August	Regiment less 1st Battalion (less Company C).[33]	1-12	Aboard R. M. S. *Orduna* enroute to Liverpool, England. (Entrained and arrived at Oxney Camp, Borden, Hampshire, England, 12th.)
			13-14	Oxney Camp, Borden, England.
		1st Battalion less Company C	1	Aboard S. S. *St. Louis* en route to Liverpool, England. (Entrained and arrived at Oxney Camp, Borden, England, 1st.)
			2-14	Oxney Camp, Borden, England.
		Regiment	15	Entrained at Liphook, proceeded to London, reviewed by King George and returned to Borden.
		do	16	Entrained at Borden, proceeded to Southampton, England, boarded R. M. S. *Huntscraft* en route to Le Havre.
			17	Enroute to Le Havre and Rest Camp No. 2 (1 mile from Le Havre).
			18-31	With American Expeditionary Forces in France.

[33] Fired upon by submarine, returned fire. No casualties.

Year	Month	Element	Dates	Station
1917 1919	Sept. 1 to Feb. 28	Regt.[24]		With American Expeditionary Force in France.
	March	do	1-17	Fleury-sur-Aire, France.
			18-19	En route to Marseilles, France.
			20-31	Camp Covington, Marseilles, France.
	April	do	1-11	Do.
			12-28	Aboard S. S. *Belvedere* enroute to New York. (Arrived Camp Mills, 28th.)
			29-31	Camp Mills, N. Y.
	May	do	1- 8	Do.
			9-12	En route to Chicago, Ill.
			13-15	Being demobilized—completed 15th.

---

[24] In order to conform to tables of organization the regiment was reorganized effective Feb. 16, 1918, in accordance with General Order No. 108, War Department, 1917.

THIRTEENTH ENGINEERS (COMBAT)

The Thirteenth Engineers (Combat) was organized January 13, 1921, at Camp A. A. Humphreys, Va., as a General Service Regiment, by transfer of personnel, both attached and assigned, pertaining to Band and First Battalion, Fifth Engineers, under authority contained in letter Office, Chief of Engineers (322.15 E–130) dated January 6, 1921, and letter Adjutant General's Office (320.13 Engrs., Misc. Div.) dated December 29, 1920. Designation changed to Thirteenth Engineers (Combat) September 6, 1928.

Year	Month	Element	Dates	Station
1921	January	Regiment	13–31	Camp A. A. Humphreys, Va.
1922	Feb. 1 to Feb. 28	do		Do.
	March	Regiment less Company F	1–31	Do.
		Company F	1–10	Do.
			11–31	Camp Bragg, N. C.
	Apr. 1 to June 30	Regiment less Company F		Camp A. A. Humphreys, Va.
		Company F		Camp Bragg, N. C.
	July	Regiment less Company F	1–31	Camp A. A. Humphreys, Va.
		Company F	1–24	Camp Bragg, N. C.
			24	Made inactive per War Department General Order 32, 1921.
	August	Regiment less 2d Battalion	1–31	Camp A. A. Humphreys, Va.
		Companies D and E	1–21	Do.
			21	Made inactive per War Department General Order 32, 1921.
		Company F		Inactive.
	September	Regiment less 2d Battalion	1–30	Camp A. A. Humphreys, Va.
		2d Battalion (Company D)		Inactive.
		(Company E)		Do.
		(Company F)		Do.
1924	Oct. 1 to May 31	Regiment less 2d Battalion		Fort Humphreys, Va.
		2d Battalion		Inactive.
	June	Regiment less Companies A, B, C, and 2d Battalion.	1–30	Fort Humphreys, Va.
		Company A	1–13	Do.
			14–30	Camp Knox, Ky.
		Company B	1–13	Fort Humphreys, Va.
			14–30	Camp Meade, Md.
		Company C	1–13	Fort Humphreys, Va.
			14–30	Camp Custer, Mich.
		2d Battalion		Inactive.
	July	Regiment less Companies A, B, C, and 2d Battalion.	1–31	Fort Humphreys, Va.
		Company A	1–31	Camp Knox, Ky.
		Company B	1–31	Camp Meade, Md.
		Company C	1–31	Camp Custer, Mich.
		2d Battalion		Inactive.
	August	Regiment less Companies B, C, and 2d Battalion.	1–31	Fort Humphreys, Va.
		Company B	1–18	Camp Meade, Md.
			19–31	Fort Humphreys, Va.
		Company C	1–31	Camp Custer, Mich.
		2d Battalion		Inactive.
	September	Regiment less 2d Battalion and Company C	1–30	Fort Humphreys, Va.
		Company C	1– 6	Camp Custer, Mich.
			6–30	Fort Humphreys, Va.
		2d Battalion		Inactive.
1925	Oct. 1 to May 31	Regiment less 2d Battalion		Fort Humphreys, Va.
		2d Battalion		Inactive.
	June	Regiment less 2d Battalion and Company B	1–30	Fort Humphreys, Va.
		Company B	1–10	Do.
			11–12	En route to Camp Custer, Mich.
			13–30	Camp Custer, Mich.
		2d Battalion		Inactive.

Year	Month	Element	Dates	Station
1925	July	Regiment less 2d Battalion and Company B	1–31	Fort Humphreys, Va.
		Company B	1–31	Camp Custer, Mich.
		2d Battalion		Inactive.
	August	Regiment less 2d Battalion and Company B.	1–31	Fort Humphreys, Va.
		Company B	1–22	Camp Custer, Mich.
			23	En route to Fort Humphreys, Va.
			24–31	Fort Humphreys, Va.
		2d Battalion		Inactive.
1927	Sept. 1 to June 30	Regiment less 2d Battalion		Do.
		2d Battalion		Do.
	July	Regiment less 2d Battalion [25]	1–31	Fort Humphreys, Va.
		2d Battalion		Inactive.
1928	Aug. 1 to Sept. 30	Regiment less 2d Battalion [26]		Fort Humphreys, Va.
		2d Battalion		Inactive.
1930	Oct. 1 to Mar. 31	Regiment less 2d Battalion		Fort Humphreys, Va.
		2d Battalion		Inactive.
	April	Regiment less 2d Battalion	1–30	Fort Humphreys, Va.
		2d Battalion [27]	1–25	Inactive.
			26–30	Fort Humphreys, Va.
	May 1 to July 31	Regiment		Do.
	August	Regiment less Companies B and E.	1–31	Do.
		Companies B and E	1–17	Do.
			18–30	Practice march.
			31	Fort Humphreys, Va.
	September	Regiment less Company F	1–30	Do.
		Company F	1– 7	Do.
			8–19	Practice march.
			20–30	Fort Humphreys, Va.
	October	Regiment less Company C	1–31	Do.
		Company C	1–12	Do.
			13–31	Fort Eustis, Va.
1931	Nov. 1 to July 31	Regiment less Company C		Fort Humphreys, Va.
		Company C		Fort Eustis, Va.
	August	Regiment less Companies A, B, and C.	1–31	Fort Humphreys, Va.
		Company A	1–30	Do.
			31	Practice march.
		Company B	1–16	Fort Humphreys, Va.
			17–29	Practice march.
			30–31	Fort Humphreys, Va.
		Company C	1–31	Fort Eustis, Va.
	September	Regiment less 2d Battalion and Companies A and C.	1–30	Fort Humphreys, Va.
		2d Battalion	1–13	Do.
			14–26	Practice march.
			27–30	Fort Humphreys, Va.
		Company A	1–11	Practice march.
			12–30	Fort Humphreys, Va.
		Company C	1–30	Fort Eustis, Va.
	October	Regiment less Company C	1–31	Fort Humphreys, Va.
		Company C	1–31	Fort Eustis, Va.
	November	Regiment less Company C	1–30	Fort Humphreys, Va.
		Company C	1	Fort Eustis, Va.
			2– 5	En route to Fort Knox, Ky.
			6–30	Fort Knox, Ky.
1932	Dec. 1 to June 30	Regiment less Company C [28]		Fort Humphreys, Va.
		Company C		Fort Knox, Ky.
	July	Regiment less Company C	1–27	Fort Humphreys, Va.
			21–29	Fort Myer, Va.
			30–31	Fort Humphreys, Va.
		Company C	1–31	Fort Knox, Ky.
	August	Regiment less Company C	1–31	Fort Humphreys, Va.
		Company C	1–31	Fort Knox, Ky.
	September	Regiment less 2d Battalion and Company C.	1–30	Fort Humphreys, Va.
		2d Battalion	1– 5	Do.
			6–18	Practice march.
			19–30	Fort Humphreys, Va.

[25] The Band was transferred from Headquarters Company and began functioning as a separate unit on July 7, 1927.

[26] Under authority of letter A. G. 320.2 Engineers (8–28–28) Misc. C dated Sept. 6, 1928 (CE. file 320.2 (13th Engineers)–4) the 13th Engineer General Service Regiment was redesignated the 13th Engineer Combat Regiment.

[27] 2d Battalion reactivated Apr. 26, 1930, under authority of letter A. G. 320.2 Engineers (1–31–30) Misc. (Returns)—C dated Apr. 8, 1930.

[28] Under authority of letter A. G. 320.2 (4–1–32) Misc. (Ret.) C dated Apr. 26, 1932 (CE. file 320.2 (Engineers, Corps of) 741) the 13th Engineers (Railway), a World War unit, was reconstituted and consolidated with the 13th Engineers (Combat).

Year	Month	Element	Dates	Station
1932	October	Company C	1-30	Fort Knox, Ky.
		Regiment less 1st Battalion	1-31	Fort Humphreys, Va.
		1st Battalion less Company C	1- 8	Maneuvers, Fort Meade, Md.
			9-31	Fort Humphreys, Va.
		Company C	1-31	Fort Knox, Ky.
1933	Nov. 1 to Apr. 30	Regiment less Company C		Fort Humphreys, Va.
		Company C		Fort Knox, Ky.
	May	Regiment less Company C	1-31	Fort Humphreys, Va.
		Company C	1- 8	Fort Knox, Ky.
			9-10	En route to Fort Humphreys, Va.
			11-31	Fort Humphreys, Va.
1934	June 1 to Mar. 31	Regiment		Do.
	April	do	1-22	Do.
			23-25	Maneuvers, Fredericksburg, Va.
			26-30	Fort Humphreys, Va.
	May	do	1-31	Do.
	June	Regiment less Companies A and D.	1-30	Do.
		Company A	1-11	Do.
			12-13	En route to Camp Custer, Mich.
			14-30	Camp Custer, Mich.
		Company D	1-11	Fort Humphreys, Va.
			12-13	En route to Fort Knox, Ky.
			14-30	Fort Knox, Ky.
	July	Regiment less Companies A and D.	1-31	Fort Humphreys, Va.
		Company A	1-31	Camp Custer, Mich.
		Company D	1-13	Fort Knox, Ky.
			14-15	Enroute to Fort Humphreys, Va.
			16-31	Fort Humphreys, Va.
	August	Regiment less Company A	1-31	Do.
		Company A	1- 2	En route from Camp Custer, Mich. to Fort Humphreys, Va.
			3-31	Fort Humphreys, Va.
	September	Regiment less 1st Battalion	1-30	Do.
		1st Battalion	1-28	Do.
			29-30	Maneuvers.
	October	Regiment less 1st Battalion	1-31	Fort Humphreys, Va.
		1st Battalion	1-13	Maneuvers.
			14-31	Fort Humphreys, Va.
1935	Nov. 1 to Jan. 31	Regiment		Do.
	February	do	1-13	Do.
			14-28	Fort Belvoir, Va.[a]
	March	Regiment less Company F	1-31	Do.
		Company F	1-26	Do.
			27-31	Fort Meade, Md.
	April	Headquarters, Headquarters and Service Company and Band and Company C.	1-30	Fort Belvoir, Va.
		1st Battalion less Company C	1- 2	Do.
			3-25	Fort George G. Meade, Md.
			26-30	Fort Belvoir, Va.
		2d Battalion less Company F	1- 2	Do.
			3-25	Fort George G. Meade, Md.
			26-30	Fort Belvoir, Va.
		Company F	1-25	Fort George G. Meade, Md.
			26-30	Fort Belvoir, Va.
	May	Regiment less Company C	1-27	Do.
			28-29	Ely's Ford, Chancellorsville, Va.
			30-31	Fort Belvoir, Va.
		Company C	1-26	Do.
			27-29	Ely's Ford, Chancellorsville, Va.
			30-31	Fort Belvoir, Va.
	June	Regiment less Companies B and D.	1-30	Do.
		Company B	1-14	Do.
			15	En route to Fort Knox, Ky.
			16-30	Fort Knox, Ky.
		Company D	1-22	Fort Belvoir, Va.
			23	En route to Camp Custer, Mich.
			24-30	Camp Custer, Mich.

[a] Designation of post of Fort Humphreys, Va., changed to Fort Belvoir, Va., per sec. I, G. O. No. 1, W. D. dated Feb. 14, 1935.

Year	Month	Element	Dates	Station
1935	July	Regiment less Companies B and D.	1-31	Fort Belvoir, Va.
		Company B	1-19	Fort Knox, Ky.
			20	En route to Fort Belvoir, Va.
			21-31	Fort Belvoir, Va.
		Company D	1-24	Camp Custer, Mich.
			25	En route to Fort Belvoir, Va.
			26-31	Fort Belvoir, Va.
	August	Headquarters	1- 9	Do.
			10-15	Maneuvers, Indiantown Gap, Pa.
			16-31	Fort Belvoir, Va.
		Headquarters and Service Company.	1- 9	Do.
			10-17	Maneuvers, Indiantown Gap. Pa.
			18-31	Fort Belvoir, Va.
		Band	1-12	Do.
			13-17	Maneuvers, Indiantown Gap, Pa.
			18-31	Fort Belvoir, Va.
		1st Battalion	1- 7	Do.
			8-15	Maneuvers, Indiantown Gap, Pa.
			16-31	Fort Belvoir, Va.
		2d Battalion less Companies D and E.	1- 5	Do.
			6-14	Maneuvers, Indiantown Gap, Pa.
			15-31	Fort Belvoir, Va.
		Companies D and E	1- 9	Do.
			10-14	Maneuvers, Indiantown Gap, Pa.
			15-31	Fort Belvoir, Va.
1937	Sept. 1 to Jan. 31	Regiment		Do.
	Feb. 1 to Dec. 31	do		Inactive.[30]

---

[30] The 13th Engineers rendered inactive as of midnight, Jan. 31, 1936, and personnel, property, and fund transferred to the 5th Engineers reactivated at Fort Belvoir, Va., on Feb. 1, 1936. (C. E. File 320.2—1148.)

FOURTEENTH ENGINEERS

This regiment was organized May 2, 1921, per G. O. 11, H. P. D., dated May 2, 1921, pursuant to letters from the War Department dated October 11, 1920, and December 21, 1920, and War Department Cable No. 1052, dated April 23, 1921, from men transferred from the First Philippine Engineers (Prov.) and Philippine Scouts, Unassigned.

Year	Month	Element	Dates	Station
1921	May	Regiment less Companies D, E, F.	2-31	Camp Eldridge, P. I.
		Companies D, E, F		Not organized.
	June	Regiment less Companies A, D, E, F.	1-30	Camp Eldridge, P. I.
		Company A	1-30	Port Area, Manila, P. I.
		Companies D, E, F		Not organized.
	July	Regiment less Companies A, B, D, E, F.	1-31	Camp Eldridge, P. I.
		Company A	1- 2	Port Area, Manila, P. I.
			3-31	Camp Eldridge, P. I.
		Company B	1- 3	Do.
			4-31	Port Area, Manila, P. I.
		Companies D, E, F		Not organized.
	August	Regiment less Companies B, D, E, F.	1-31	Camp Eldridge, P. I.
		Company B	1-31	Port Area, Manila, P. I.
		Companies D, E, F		Not organized.
	September	Regiment less Companies A, B, D, E, F.	1-22	Camp Eldridge, P. I.
			23-30	Fort William McKinley, P. I.
		Company A	1-30	Camp Eldridge, P. I.
		Company B	1- 3	Port Area, Manila, P. I.
			4-22	Camp Eldridge, P. I.
			23-30	Fort William McKinley, P. I.

NOTE.—Companies D, E, F organized by transfer of enlisted personnel from Companies E, F, and I, 62d Infantry (P. S.), respectively, at Fort Mills, P. I., on Sept. 22, 1921, pursuant to par. 2, G. O. No. 2, Headquarters Philippine Department, dated Sept. 21, 1921. Companies D, E, F at Fort Mills since 24th awaiting transportation to Fort William McKinley. A 6-letter company regiment now.

Year	Month	Element	Dates	Station
		Companies D, E, F	24-30	Fort Mills, P. I.
	October	Regiment less Companies A, D, E, F.	1-31	Fort William McKinley, P. I.
		Company A	1-31	Camp Eldridge, P. I.
		Companies D, E, F	1- 3	Fort Mills, P. I.
			4-31	Camp Eldridge, P. I.
	Nov. 1 to Jan 31	Regiment less Company A		Fort William McKinley, P. I.
1922		Company A		Camp Eldridge, P. I.
	February	Regiment less Companies A, B, C.	1-28	Fort William McKinley, P. I.
		Company A	1-13	Camp Eldridge, P. I.
			14-28	Fort William McKinley, P. I.
		Companies B and C	1-28	D. S. Topographical Survey, Bataan Peninsula, P. I.
	Mar. 1 to May 31	Regiment less Companies B and C.		Fort William McKinley, P. I.
		Companies B and C		D. S. Topographical Survey, Bataan Peninsula, P. I.
	June	Regiment less Companies B and C.	1-30	Fort William McKinley, P. I.
		Companies B and C	1- 5	D. S. Topographical Survey, Bataan Peninsula, P. I.
		Companies B and C	6-30	Fort William McKinley, P. I.
	July 1 to Aug. 31	Regiment		Do.
	September	do	1-11	Do.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.[31]	12-30	Inactive.
		1st Battalion and 1 Battalion section of Hq. & Serv. Company.	12-30	Fort William McKinley, P. I.

---

[31] 1st Battalion organized T/O 68F and Headquarters and Service Platoon organized T/O 466 P.

Year	Month	Element	Dates	Station
1922	Oct. 1 to Dec. 31	1st Battalion and Hq. & Serv. Platoon.		Inactive.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Do.
1923	Jan. 1 to May 31	1st Battalion less Company C and Hq. & Serv. Platoon.		Limay, Bataan, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	June	1st Battalion less Company C and Hq. & Serv. Platoon.	1–10	Limay, Bataan, P. I.
			11–30	Fort William McKinley, P. I.
		Hq. & Serv. Platoon and Company C.	1–30	Do.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	July 1 to Dec. 31	1st Battalion and Hq. & Serv. Platoon.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
1924	January	1st Battalion and Hq. & Serv.	1– 9	Fort William McKinley, P. I.
			9–31	Mariveles, Bataan, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	Feb. 1 to Apr. 30	1st Battalion and Hq. & Serv. Platoon.		Mariveles, Bataan, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	May	1st Battalion and Hq. & Serv. Platoon.	1– 9	Mariveles, Bataan, P. I.
			10–31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	June	1st Battalion and Hq. & Serv. Platoon.	1–30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	July	1st Battalion and Hq. & Serv. Platoon.	1–16	Fort William McKinley, P. I.
		1st Battalion and Hq. & Serv. Company.	17–31	Do.
		Regiment less 1st Battalion and Hq. & Serv. Platoon.	1–16	Inactive.

NOTE.—The Hq. & Serv. Platoon, 1st Battalion 14th Engineers (P. S.) changed to Hq. & Serv. Company, 14th Engineers (P. S.) July 16, 1924, in accordance with War Department Circular No. 39, 1924—Organized in accordance with columns 6, 7, and 8, table 466 P. & W.

Year	Month	Element	Dates	Station
		Regiment less 1st Battalion and Hq. & Serv. Platoon.	17–31	Inactive.
	Aug. 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	November	1st Battalion	1–16	Fort William McKinley, P. I.
			17–30	Paysavan, Bataan, P. I.
		Hq. & Serv. Company	1–30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	Dec. 1	1st Battalion		Paysavan, Bataan, P. I.
	to	Hq. & Serv. Company		Fort William McKinley
1925	Feb. 28	Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	March	1st Battalion	1–24	Paysavan, Bataan, P. I.
			25–31	Fort William McKinley, P. I.
		Hq. & Serv. Company	1–31	Do.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	Apr. 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	November	1st Battalion less Company C	1–30	Fort William McKinley, P. I.
		Company C	1– 9	Do.
			10–30	Alasasin Point, Bataan, P. I.
		Hq. & Serv. Company	1–30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.

Year	Month	Element	Dates	Station
1925	December	1st Battalion less Company C	1-31	Fort William McKinley, P. I.
		Company C	1-19	Alasasin Point, Bataan, P. I.
			20-31	Fort William McKinley, P. I.
		Hq. & Serv. Company	1-31	Do.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
1926	January	1st Battalion less Company B	1-17	Fort William McKinley, P. I.
			18-27	Maneuvers.
			28-31	Fort William McKinley, P. I
		Company B	1- 4	Do.
			5-31	Alasasin Point, Bataan, P. I.
		Hq. & Serv. Company	1-17	Fort William McKinley, P. I.
			18-27	Maneuvers
			28-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	February	1st Battalion (less Companies A and B) and Hq.& Serv Company.	1-28	Fort William McKinley, P. I.
		Company A	1-19	Do.
			20-28	Alasasin Point, Bataan, P. I.
		Company B	1-20	Do.
			21-28	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	March	1st Battalion (less Company A) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1-31	Alasasin Point, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	April	1st Battalion (less Company A) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company A	1-13	Alasasin Point, Bataan, P. I.
			14-30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	May 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	November	1st Battalion (less Company A) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company A	1	Do.
			2-30	Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	December	1st Battalion (less Company A) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1-24	Bataan, P. I.
			25-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
1927	January	1st Battalion (less Company C) and Hq. & Serv. Company.	1- 4	Fort William McKinley, P. I.
			5-19	Maneuvers.
			20-31	Fort William McKinley, P. I.
		Company C	1- 4	Do.
			5-31	Limay, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	February	1st Battalion (less Companies A and C) and Hq. & Serv. Company.	1-28	Fort William McKinley, P. I.
		Company A	1-23	Do.
			24-28	Camp Eldridge, Los Banos, P. I.
		Company C	1-28	Limay, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	March	Headquarters 1st Battalion and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1-31	Camp Eldridge, Los Banos, Laguna, P. I.
		Company B	1- 4	Fort William McKinley, P. I.
			5-31	Orani, Bataan, P. I.
		Company C	1- 5	Limay, Bataan, P. I.
			6-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	April	1st Battalion (less Companies A and B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company A	1-30	Camp Eldridge, Los Banos, Laguna, P. I.
		Company B	1-30	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.

Year	Month	Element	Dates	Station
1927	May	1st Battalion (less Companies A and B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1-31	Camp Eldridge, Los Banos, Laguna, P. I.
		Company B	1-5 6-31	Orani, Bataan, P. I. Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	June	1st Battalion (less Company A) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company A	1-19 20-30	Camp Eldridge, Los Banos, Laguna, P. I. Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	July 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	November	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1-27 28-30	Do. Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	December	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-31	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
1928	January	1st Battalion (less Company B) and Hq. & Serv. Company.	1- 7 8-23 24-31	Fort William McKinley, P. I. Maneuvers. Fort William McKinley, P. I.
		Company B	1-31	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	Feb. 1 to Apr. 30	1st Battalion (less Company B) and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Company B	--------	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	May	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-13 14-31	Orani, Bataan, P. I. Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	June 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	November	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1 2-30	Do. Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	Dec. 1 to Mar. 31	1st Battalion (less Company B) and Hq. & Serv. Co.	--------	Fort William McKinley, P. I.
1929		Company B	--------	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	April	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1-24 25-31	Orani, Bataan, P. I. Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	May 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	November	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1 2-30	Do. Olongapo, Zambales, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	December	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-31	Olongapo, Zambales, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.

Year	Month	Element	Dates	Station
1930	January	1st Battalion (less Company B) and Hq. & Serv. Company.	1- 8	Fort William McKinley, P. I.
			9-16	Maneuvers.
			17-31	Fort William McKinley, P. I.
		Company B	1-31	Olongapo, Zambales, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	Feb. 1 to Apr. 30	1st Battalion (less Company B) and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Company B		Olongapo, Zambales, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	May	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-28	Olongapo, Zambales, P. I.
			29-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	June	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1- 2	Quartermaster's Barracks, Manila, P. I.
			3-30	Gumaca, Tayabas, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	July 1 to Nov. 30	1st Battalion (less Company B) and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Company B		Gumaca, Tayabas, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	December	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1	Gumaca, Tayabas, P. I.
			2-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
1931	January	1st Battalion (less Company B) Hq. & Serv. Company.	1- 3	Fort William McKinley, P. I.
			4-15	Maneuvers.
			16-20	Fort William McKinley, P. I.
			21-30	Maneuvers.
			31	Fort William McKinley, P. I.
		Company B	1-31	Do.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	February	1st Battalion (less Company B) and Hq. & Serv. Company.	1-28	Fort William McKinley, P. I.
		Company B	1- 2	Do.
			3-28	Gumaca, Tayabas, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	March	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-31	Gumaca, Tayabas, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	April	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1-10	Gumaca, Tayabas, P. I.
			11-30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	May 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	November	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1- 2	En route to Bongabong, Nueva Ecija, P. I.
			3-30	Bongabong, Nueva Ecija, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	December	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-31	Bongabong, Nueva Ecija, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Co.		Inactive.
1932	January	1st Battalion (less Company B) and Hq. & Serv. Company.	1- 7	Fort William McKinley, P. I.
			8-21	Maneuvers.
			22-31	Fort William McKinley, P. I.
		Company B	1-31	Bongabong, Nueva Ecija, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.

Passing tracks.

59. These need no special mention. They are simply added when and where traffic demands them.

Tracks on docks and from docks to yards.

60. There are usually at least three tracks used on a dock in front of the classification shed to take the cargo direct from ship. With three tracks cars can stand on one to receive loads and be moving on and off on the other two. If rails are laid at floor level, supplies can more easily be moved by animal, by truck, or by hand truck off the dock into the classification shed. Back of the classification shed there should be two or more tracks to receive cargo from this shed. Two or more tracks should be laid from the dock to receiving, classification, and departure yards. The layout of the Bassens terminal yards near Bordeaux is shown on plate 137 of folio.

Railroad yards.

61. At places where trains are made up and at depots, receiving classification and departure yards with tracks from 1,500 to 2,000 feet long are necessary. Tracks in France were spaced first with 14-foot centers, then with 16 foot centers, to permit locomotive cranes on hand to be used. While plans should be made providing for ultimate expansion into elaborate yards, the construction should be carried on progressively to fit immediate and urgent needs. In France plans were never completed entirely. Supplies moved eastward only, and all types of cars were used for any and all purposes indiscriminately, so the need for classification westward did not exist, since only empties traveled in that direction. The following is about the way yards should be developed, assuming loads are to move only in one direction (eastward, for instance):

62. Eastbound receiving yard: First installation, three tracks; more to be added as necessity develops.

63. Eastbound classification yard: First installation, eight tracks; more to be added as necessity develops.

64. Hump between receiving and classification yard, a by-pass around hump to be added when practicable.

65. Eastbound departure yard and another classification yard will be added to meet demands, the tracks being increased as necessity develops. At first one receiving yard and one classification yard will be used for receiving, classification, and departures in both directions. Finally, westbound receiving and departure yards may be used, but the necessity for westbound classification may not develop. It depends upon the location and conditions whether one yard with many tracks is used for receiving and departure or whether the tracks are divided into two yards.

66. The layout used at Gievres, France, shown on plate 138 of folio, served the intermediate depot; served as an engine terminal;

and during the German attacks near Château-Thierry served as an advance depot and regulating station for the Paris group of American forces. In other words, these yards were made to serve every requirement under most difficult conditions. They were constructed on the principles outlined above. One track (about 1,700 feet long) along one side of the storehouses was found sufficient. The yard was designed with the idea that each storehouse was similar to a freight storehouse in New York, Chicago, or San Francisco, where freight comes in and goes out of the same house at the same time. In such a storehouse freight comes in for Jones, Smith, etc., at the same time that it is going out for Thompson, Jackson, etc., so the facilities for handling into the house from cars and out of the house into cars at the same time are necessary. At Gievres it was different. Everything that came in was for Uncle Sam and everything that went out was for Uncle Sam, and practically everything that came in on the railroad went out on the railroad. One house generally carried only one article, and if that article was to be shipped to Uncle Sam, the same article, if in cars to be unloaded, would simply be reconsigned in the same cars without unloading. The entire yard of about 125 storehouses was just as if it were one house with many tracks through it. Unloading and loading from the same tracks was never necessary because each particular item was always stored on more than one track. Items coming in would be unloaded on entirely different tracks from the one on which loading was necessary. In the area where wagons were unloaded, assembled, and then reloaded for the front, three adjacent tracks and a locomotive crane were used. Of course, such a layout as this is constructed as the facilities are needed, and where topography makes construction difficult that part of the yard is simply omitted and extensions are made where construction is easy and rapid. Ballasting was not done here at all, and is never done until it is demonstrated to be necessary.

Engine terminals.

67. On a main line engine terminals are placed about 75 or 100 miles apart. These terminals consist of receiving yard, turntable or wye, ashpit, inspection pit, water tank, coaling facility, engine house, boiler house, oil house, standing tracks, and departure yard. A classification yard is necessary only if trains are broken and made up anew at the terminal. A layout used at Saumar, France, is shown on plate 139 of folio.

68. The yards are constructed progressively to meet demands.

69. Ashpit is shown on plate 140. Ashes are handled by hand. If concrete is not available this pit can be made with old ties.

70. Inspection pit is shown on plate 141. If concrete is not available this pit can be made with old ties.

71. Coaling facility is shown on plate 142. At Gievres the coal was simply put in a pit dug in the ground without the lumber work shown on the drawing.

72. Engine house is shown on plate 143. This plan follows civil practice. It should have consisted of simple sheds, containing each about two tracks. Thus there would have been light from the sides, and the complicated sawtooth construction requiring glass would have been avoided.

73. Boiler and oil houses should be simply corrugated forms of houses.

Water tanks.

74. Water tanks have to be placed on main lines about every 10 or 15 miles apart, at engine terminals, and at places where switching is necessary. A tank design following standard civil practices is shown on plate 144 of folio. However, tanks can be improvised from any lumber available. A plank 3 inches thick is desirable. When tank has to be improvised, 25,000 gallons is a convenient size. Posts for such a tank can be 8 by 8 inches, resting on wooden blocks instead of concrete. Any available iron rods can be used for bands. If turnbuckles are not available, a substitute can be improvised by taking a piece of pipe, mashing it together in the middle longitudinally, and passing the rods through the two tubes thus formed and securing them with nuts on opposite ends. If regular crane and large pipe is not available, 4 or 6 inch pipe and fittings can be used.

Railroad shops.

75. Existing shops will probably be used, but they may require additions and improvements to meet conditions of extra traffic.

Regulating station.

76. A regulating station is nothing more than yards to receive, classify, and make up trains for serving troops with a daily automatic supply. Cars containing complete rations are made up into trains, so that cars for one unit, generally a division, can be easily shifted out of a train. Supplies for a division for one day, other than ammunition, generally require cars carrying from 50 to 80 tons. The regulating officer receives requisitions from troops and supervises the making up of trains. A regulating station may or may not be at the same place as the advance depot. A layout of a combined regulating station and advance depot is shown on plate 145 of folio and a regulating station without advance depot is shown on plate 146.

Railhead sidings.

77. Where a division receives its supplies, sidings and storehouse space are necessary to only a limited extent. As the supply is

automatic and daily, usually store space for one or two days' supply with corresponding sidings is sufficient. A railhead used at Sorcy, France, is shown on plate 147 of folio.

OIL AND GASOLINE STORAGE.

78. In France tanks and tank cars were used for gasoline only. In order not to have to clean tanks, heavy oils and greases were transported and stored in containers.

Large tanks.

79. Fifty thousand barrel storage tanks were erected in several places in France. Near the ports additions were made to existing commercial plants, and the tanks were erected on concrete foundation. These foundations near water were not considered safe without concrete. At Gievre tanks were placed on the natural ground. A railroad siding was necessary, and pipe connections from tanks to cars. The Gievre layout on plate 138 includes a gasoline and oil depot.

Small tanks.

80. A large number of small tanks were fabricated at Gievre and were sent all over France for use at gasoline-filling stations.

AMMUNITION DEPOTS.

81. Depots for ammunition other than small-arms ammunition are constructed separately from general depots.

Layout.

82. In France advance ammunition depots were so laid out that each storehouse (about 50′ by 500′) was located apart from other storehouses. Intermediate and base depots were first laid out with the storehouses in groups of eight houses, each 50 by 1,000 feet. Later the depots in the rear were designed on the same principle as the advance depots. On plate 148 of folio is shown layout of the first intermediate ammunition depot constructed, and on plate 149 is one constructed later at Issoudun. The advance ammunition depot is shown on plate 150. A bomb and grenade depot is shown on plate 151.

Railroad yard.

83. Although yards of 11 or more tracks were planned in France, 5 tracks filled every need which developed. A water tank near the yard was found necessary.

84. The sheds for ammunition are the same as the sheds for general stores shown on plates 154 and 155 of folio. Designs of sheds, with earth protection on the sides and overhead, were made in France, but there was never material and labor for such construction. Such

a storehouse would simply make an explosion more disastrous if it occurred, as the earthen walls and roof would act as tamping for the explosive. Safety is gained by separating the ammunition so as to localize any explosion. Intermediate and base depots are located beyond the range of hostile aeroplanes, so protection for them is not logical. Separation of storehouses gives a certain amount of concealment from aeroplanes. As a matter of fact, a great deal of the ammunition in the World War was stored outside, and this can be done in any war if materials and labor are too scarce to permit of the construction of storehouses. If sheds are constructed, it is not necessary to build the ground in them up to car level, since in war manpower for operations is always more plentiful than building facilities. It is important to get something that can be used quickly and to give little weight to number of men necessary for operation.

Electric lighting.

85. At the advance depot in France electric lights were installed in the sheds, and power units were placed on push cars so that they could be placed on tracks adjacent to shed and connection made to lighting wires. It is rare that loading is going on from more than one or two sheds at the same time at night. At intermediate and base depots night work will rarely be necessary, so electric lights are not essential.

Personnel.

86. The operating personnel for an ammunition depot in France was about 1,000 men, and camps for them were located on existing roads near by. It is better to locate men in separate small camps, if possible, so that there are workmen near all parts of the depot.

GENERAL STORAGE DEPOTS.

Plans and development.

87. All supplies other than ammunition, aeroplanes, and motor vehicles will ordinarily be stored in general storage depots, whose location will depend upon conditions. The plan on plate 138 of folio shows the storage depot at Gievres, France, in the intermediate section. This layout was used most in France and was successful. It was constructed progressively according to immediate and urgent needs and was never completed according to plan.

88. The storehouse area is laid out in sections, each section having a ladder track on each side connected by house tracks about 1,700 feet long, there being one of these to each three warehouses. These tracks are about 150 feet apart, which gives space enough for open storage on the opposite side of the track from the houses, as well as space for fire breaks. A section can be started with a ladder track on one side, the ladder on the other side to be added later. Running tracks are added when found necessary.

89. The plan on plate 152 shows the depot at Montierchaume, France, which depot was planned after experience had shown the proper methods of development. This layout shows spaces assigned to each department, coal tracks, hay tracks, explosive spur, etc. This depot was developed on the proper principles. The drawing on plate 153 gives more detail and also shows what was actually done at the end of the war.

90. In constructing a storage depot, in the beginning the space should be laid out in separate areas for each department of the Army, in the proportion of the tables which follow, and the construction should proceed so that each department can begin storing supplies and expand without mixing up its supplies with those of other departments. At Montierchaume all the railroad sections were started at the same time, so each department could start and have its own expansion area.

91. In addition, different types of storehouses should be distributed on separate tracks, so that any one commodity can be stored on separate tracks; this so that, if desirable, the same commodity may be loaded from one track while it is being received on another.

92. The grouping and building of houses should more or less fit departmental organizations when practicable. For instance, the Quartermaster desires his rations and his clothing in separate groups which can expand simultaneously.

93. In constructing the yards, no existing roads should be closed by warehouses or tracks, as roads are almost impossible to construct with the means at hand, and available roads should be used.

94. Each department will desire one or more storehouses from which shipments can be made by truck. These warehouses should be selected adjacent to existing roads, so that each department has one warehouse on a road. At Montierchaume wagon yards and open Engineer storage were distributed throughout the depot to make fire breaks between the storehouses.

95. In addition to the departments shown in the tables hereafter, there are a number of small additional departments which may require space in a depot for a force of a million or more men, viz, Red Cross, 25,000 square feet; Y. M. C. A., 50,000 square feet; American Library Association, 20,000 square feet; and fire prevention, 25,000 square feet. Usually these departments desire storehouses along an existing road, so that their storage will be accessible for trucks.

Fire protection.

96. In the design of the depots the warehouses are intentionally spaced far enough apart so that fire can not spread from one to another, and groups of warehouses are separated by open storage spaces. In addition, much of the contents of the warehouses is

not inflammable, and generally the warehouses are built of corrugated iron and are not extremely inflammable. No artificial fire protection is necessary. The cost of such a system in material far exceeds any probable loss from fire. Fire should be prevented from spreading by keeping the areas between the warehouses clear of rubbish and inflammable material. To lower the fire risk, all offices and facilities which use fires should, whenever practicable, be located outside of the sections which contain warehouses.

97. At Montierchaume wagon yards and open Engineer storage were distributed throughout the depot to make fire breaks between storehouses.

Hay and dynamite.

98. Sidings or spurs far removed from other stores are laid for the storage of hay and dynamite; this for localizing fire risk.

Coal pile.

99. A reserve coal pile in addition to the coaling facility for locomotives may be necessary. Such a pile is formed by unloading by hand from two or more tracks. As the coal increases the tracks are raised until the pile gets about 10 feet high at the higher end, then a new pile is started. Cars standing on tracks laid on level ground alongside such a coal pile can be loaded with coal when it is desired for use. Coal piles such as described may catch on fire inside; for this reason their height should be limited to about 10 feet and they should have spaces between them. If fire develops, it has to be stopped by digging around the fire and localizing it.

Warehouses.

100. The storehouse most used in France was 50 feet wide and 400 or 500 feet long. It was made with wooden frame and corrugated-iron roof and sides. The two types used are shown on plates 154 and 155 of folio. Type "B" is easier than type "C" to construct but not so strong. Both houses have very small factors of safety and should be strengthened if used where large wind or snow loads are expected. In France frequently no sides were put on these houses, and they were used as sheds. Sides were placed only on the houses which carried perishable supplies, such as flour or sugar. In place of windows, when siding was used it was simply carried up to within about a foot or 18 inches of the roof, and a continuous opening was left at the top, which was protected by the eaves. Doors were generally not used, canvas being placed over openings where it was necessary to close them. Of course, this did not contemplate protection from theft except by guarding. The frames of buildings were made with round posts and rough lumber. Mostly no floors at all were placed. Dunnage was used to keep supplies off the damp ground. Supplies very sensitive to water, such as

flour and sugar, were placed on a floor or dunnage consisting of wood poles with rough-edged plank laid on them. Economy in labor of operations is of minor importance in war, so floors at car level do not warrant the labor, materials, and time necessary to construct.

101. In addition to the flimsy structures described above, there were used in France some all-metal warehouses of the same sizes as the wooden framed ones. One type of steel building came from America and another type came from England. The two types illustrated the difference in proper constructing methods in peace and in war. The American building was perfectly safe and was good for many years. The English building had a very small factor of safety and was good for only one or two years. The American building consisted of many different and noninterchangeable parts, while the English building had more simple parts. One hundred such American buildings were received in France, and they were of different designs. It proved exceedingly difficult to get the parts of any one building together. In addition, some parts were so heavy that handling was very difficult. These buildings should have all been of the same design, their parts should have been as nearly interchangeable as possible, and there should have been as few unlike parts as possible. The parts should have been light, and the entire building could have been much lighter and less durable, thereby saving labor, material, and time.

102. In war materials are necessarily scarce, and just as no labor-saving construction is warranted, likewise absolute safety from fire, theft, and weather is not as important as in peace time, since everything is more or less temporary and chances must be taken. Forty per cent of the rations and a large proportion of other stores can be stored outside for periods of two or three months without any appreciable loss. It is useless for the supply features in war to play a perfectly safe game, when at the front large losses are a mere incident.

Cold storage.

103. Where soldiers are to have fresh meat, cold-storage plants may be necessary. These are used only to freeze or store meat between shipments, and not to store a reserve supply. Reserve rations are kept in the form of canned meats. In France some plants of this kind were built. The one at Gievres, with rated capacity of 5,000 tons, stored at times 6,500 tons of meat, it being piled in quarters with 2 by 4 inch strips in between. The floor space used was 896 by 110 feet, with about 11 feet head room. This makes the area occupied from 15 to 20 square feet per ton stored. These plants were first designed in the same way that they are designed in civil practice. Later they were modified, and when built the ice-freezing feature was omitted entirely, spare boilers were omitted, and water for condensing purposes was omitted. While such a structure, on account of its

technical nature, must be most carefully constructed, a designer having in mind the military requirements of simplicity, economy of materials and time, and the lack of durability, can modify for the better the structure designed from civil experience. Cold-storage plant drawings are shown on plates [illegible] to [illegible] of folio.

Bakeries.

104. If the depot is required to make automatic shipments of rations to the front, bakeries may be necessary. It is necessary to carefully consider their location with reference to water, since the water requirements of a bakery are very large. In war, where simplicity is the rule, a corrugated-iron house for each bakery company to operate in is better than attempting any complicated mechanical bakery affair. The house can be constructed to fit the bakery organization. Sometimes it is difficult to get fire brick desired for use with the field bakeries, but as they are supposed to operate in the field, the lack of such brick should not be serious.

Coffee-roasting plant.

105. In France the Quartermaster started buying green coffee, which necessitated coffee-roasting plants at some of the depots. Where 30,000,000 rations were stored, the coffee-roasting house was about 20,000 square feet in area. The machinery is sometimes operated by electric power and sometimes by steam power.

Freight house for small shipments.

106. The depot will probably have to make a larger number of less than carload shipments from the various departments, and it will probably be necessary to use about 15,000 square feet for a shipping warehouse for less than carload shipments. This warehouse should be located near a connection to the main-line outgoing railroad.

Post warehouse.

107. The post, to serve the personnel which operated the depot, will need a warehouse for issue purposes. This warehouse should contain from 20,000 to 25,000 square feet and should be located on a road outside of the depot area, since it is important that the post issuing department should not be mixed up with the depot departments. This warehouse should be on a siding.

Offices.

108. Each department of the Army will need office space, which may develop to about the following for a depot carrying 30 days' supply for 1,000,000 men; Quartermaster, 8,000 square feet; Engineers, 6,000 square feet; Ordnance, 2,000 square feet; Medical, 2,000 square feet; Signal Corps, 2,000 square feet. The respective offices should be located outside of the railroad sections and adjacent to the areas occupied by the departments which they serve.

109. The operating personnel used at the intermediate storage depot at Gievres, France, which depot carried 30 days' supply for 1,000,000 men, was:

Quartermaster	8, 308
Ordnance	513
Signal	524
Engineer depot	1, 820
Medical	460
Chemical Warfare	44
Gasoline and oil	250
Y. M. C. A	88
Red Cross	31
Transportation	1, 419
Construction	1, 900
Miscellaneous guards, convoys, etc	6, 250
Total	21, 607

110. Camps for operating personnel should be located on existing roads, and should be distributed around the depot, so that personnel belonging to each department is within walking distance of its work. Such distribution lends itself also to sanitation and small fire risk.

Water supply.

111. In addition to water for personnel, there will be water for locomotives, and possibly ice plants and bakeries. One depot in France expected to use about 500,000 gallons per day. The personnel got water from wells, while the ice plant and locomotives were mainly supplied from a near-by river.

Electricity.

112. The working of labor at night is an uneconomical procedure, and is avoided as much as possible. Experience has shown that in the intermediate and base depots very little night work is necessary, so it is unnecessary to install electirc lights in the warehouses. On rare occasions when night work is necessary, acetylene flares can be used.

Storage space requirement.

113. The following tables show quality of storage, for various items of supply and space allowances found by experience to be necessary:

TABLE I.—*Classification of supplies for purpose of storage.*

QUARTERMASTER.

Materials for which continuous cover must be provided.	Materials which may be stored in open without serious deterioration.
Subsistence: Sugar. Flour. Rice. Subsistence not in tins. Oats and bran. Clothing and equipment. Fine hardware. Harness and accessories.	Subsistence: Tinned goods, except butter. Soap. Vinegar. Hay. Animal transportation. Miscellaneous supplies.
Percent of total bulk, 48.	Per cent of total bulk, 52.

Table I.—*Classification of supplies for purpose of storage*—Continued.

MOTOR TRANSPORT.

Materials for which continuous cover must be provided.	Materials which may be stored in open without serious deterioration.
Motor parts. Hand tools. Machine tools. Pneumatic tires. Tubes. Lamps. Horns. Tarpaulins.	Complete vehicles and chassis. Solid tires. Steel and iron shapes. Bows. Bodies.
Per cent of total bulk, 65.	Per cent of total bulk, 35.

ORDNANCE.

General Ordnance property. Fixed artillery ammunition and powder charges. Stokes mortar bombs.	Small-arms ammunition. Projectiles. Hand grenades. Trench bombs. Guns, caissons, and limbers. Tractors. Helmets.
Per cent of total bulk, 50.	Per cent of total bulk, 50.

AIR SERVICE.

Airplanes. Airplane engines. Spare parts. Photographic supplies. Clothing. Radio equipment. Small hardware.	Bombs and ammunition. Armament. Gasoline. Transportation.
Per cent of total bulk, 65.	Per cent of total bulk, 35.

MEDICAL.

Medicine. Antiseptics. Disinfectants. Laboratory supplies. X-ray supplies. Surgical instruments and dressings. Dental supplies. Veterinary supplies.	Enamelware. Beds. Glass. Woodenware.
Per cent of total bulk, 85.	Per cent of total bulk, 15.

LIGHT RAILWAYS.

Shop supplies. Fine hardware. Machinery tools. Hand tools.	Rolling stock. Track material. Tractors. Road machinery.
Per cent of total bulk, 4.	Per cent of total bulk, 96.

SIGNAL.

Meteorological instruments. Telephone instruments. Telegraph instruments. Inside hardware. Electrical equipment. Field glasses. Watches. Clocks, etc.	Cable. Wire. Poles. Cross-arms. Lance poles. Pole fittings. Line hardware. Insulators.
Per cent of total bulk, 60.	Per cent of total bulk, 40.

TABLE I.—*Classification of supplies for purpose of storage*—Continued.

CHEMICAL WARFARE.

Materials for which continuous cover must be provided.	Materials which may be stored in open without serious deterioration.
Respirators. Chloride of lime. Bursting and propellant charges. Instruments. Blanket cloth. Alarm devices. Stokes mortars. Livens component parts.	Gas cylinders. Bombs.
Per cent of total bulk, 57.	Per cent of total bulk, 43.

ENGINEER.

Instruments: Electrical and mechanical supplies. Stationery. Cement. Fine hardware. Manila rope. Harness and accessories.	Building materials: Tar paper. Wall board. Corrugated iron. Generator sets. Sandbags. Pipe and pipe fittings. Road machinery. Tractors. Miscellaneous supplies: Shovels. Picks. Heavy hardware.
Per cent of total bulk, 10.	Per cent of total bulk, 90.

TABLE II.—*Space and quality of storage required for 30,000,000 rations.*

	Cubic feet per 100 pounds net.	Number of pounds in 30,000,000 rations.	Volume in 30,000.000 rations.	Height.	Area.	Aisle area.	Total area required.
			Cubic feet.	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*
Butter, lard, etc	3.62	1,070,000	38,900	6	6,450	1,290	7,030
Beans, issue	1.76	4,500,000	79,300	10	7,930	1,600	15,860
Bread, hard	5.55	30,000,000	1,665,000	6	277,500	55,500	333,000
Coffee	4.86	2,100,000	102,150	6	17,030	2,350	19,380
Flour	1.62	33,750,000	548,440	10	54,900	11,000	65,900
Fruit, canned	3.00	2,400,000	72,000	....	12,000	2,400	14,400
Fruit, dried	2.08	2,400,000	49,200	....	8,320	1,660	9,986
Meats, canned	3.33	30,000,000	999,000	....	166,500	33,100	199,600
Salt	1.43	1,200,000	17,160	....	2,860	570	3,430
Spices	7.80	60,625	3,946	....	658	132	790
Vegetables, canned	3.03	26,250,000	795,375	....	132,560	26,510	159,070
Vegetables, fresh	2.44	37,500,000	915,000	....	152,500	30,500	183,000

	Warehouse requirements.			
	Over 60 days.		Under 60 days.	
	Piled on—	Piled in—	Piled on—	Piled in—
Butter, lard, etc	Poles	House	Poles	Shed.
Beans, issue	Slabs or poles	do	do	House.
Bread, hard	Poles	do	do	Shed.
Coffee	do	do	do	Do.
Flour	Slabs or poles	do	do	House.
Fruit, canned	Poles	do	do	Open.
Fruit, dried	do	do	do	Shed.
Meats, canned	do	do	do	Open.
Salt	do	do	do	Shed.
Spices	do	do	do	Do.
Vegetables, canned	do	do	do	Open.
Vegetables, fresh	do	do	do	Shed.

TABLE III.—*Space and quality of storage required for forage.*

	Ration, unit.	Volume.	Height.	Area.	Aisle area.	Total area.	Warehouse requirements.			
							For under 60 days.		For over 60 days.	
							Piled on—	Piled in—	Piled on—	Piled in—
		Cu. ft.	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*				
Hay	1,000,000	523,000	20	52,300	10,500	73,000	Ground	Open	Poles	Open.
Oats	1,000,000	304,000	10	30,400	6,080	36,480	Slabs or poles.	House	Slabs or poles.	House.

TABLE IV.—*Space and quality of storage required for 1,000,000 Ordnance equipments (personnel).*

	Volume.	Area piled 9 feet high.	Aisle area.	Total.	Warehouse requirements.	
					In boxes, piled on—	In boxes, piled in—
	Cubic feet.	*Feet.*	*Sq. ft.*	*Sq. ft.*		
Meat-can cover	24,000	2,667	533	3,200	Ground	House.
Meat can	83,000	9,222	1,844	11,066	do	Do.
Canteen cups	57,000	6,333	1,267	7,600	do	Do.
Knives	1,500	167	33	200	do	Do.
Forks	1,000	111	22	133	do	Do.
Spoons	1,000	111	22	133	do	Do.
Bayonet and scabbard	46,000	5,111	1,022	6,133	do	Do.
Bolo and scabbard	29,000	3,222	644	3,866	do	Do.
Bacon can	50,000	5,556	1,111	6,667	do	Do.
Condiment can	36,000	4,000	800	4,800	do	Do.
Canteen cover	84,000	9,333	1,867	11,200	do	Do.
Gun slings	7,200	800	160	960	do	Do.
Rear belt suspender	4,000	444	89	533	do	Do.
Haversack and car	150,000	16,667	3,333	20,000	do	Do.
Hand axes	50,000	5,556	1,110	6,666	do	Do.
Magazine carrier	14,000	1,556	310	1,866	do	Do.
Pick carrier	20,000	2,222	444	2,666	do	Do.
Hand ax carrier	24,000	2,667	533	3,200	do	Do.
Hatchet	40,000	4,444	889	5,333	do	Do.
Hatchet carrier	20,000	2,222	444	2,666	do	Do.
Shovel carrier	20,000	2,222	444	2,666	do	Do.
Pistol	81,000	9,000	1,800	10,800	do	Do.
Pistol holster	70,000	7,778	1,555	9,333	do	Do.
Pistol belt	20,000	2,222	444	2,666	do	Do.
Pouch, first-aid	5,000	555	111	666	do	Do.
Pouch, small articles	20,000	2,222	444	2,666	do	Do.
Rifle	990,000	110,000	22,000	132,000	do	Do.
Trench knife	39,000	4,333	867	5,200	do	Do.
Hand rifle, gr. car	60,000	6,667	1,333	8,000		
Total				272,885		

TABLE V.—*Space requirement for horse ordnance equipment.*

STORED IN HOUSES OR SHEDS ON DUNNAGE.

	Unit.	Volume.	Area piled 9 feet high.	Aisle area.	Total.
		Cubic feet.	*Feet.*	*Sq. feet.*	*Sq. feet.*
Bridles (French)	5,000	1,800	200	40	240
Bridles (U. S. Cavalry)	5,000	1,100	122	24	146
Saddles (French)	5,000	9,000	1,000	200	1,200
Saddles (U. S. McClelland)	5,000	6,000	667	133	800
Saddles (mule)	5,000	5,000	556	111	667
Loose harness (French)	10,000	39,960	4,440	888	5,320
Leather, in bundles	10,000	270	30	6	36
Horse-cover blanket	10,000	3,600	400	80	480
Saddle blankets	10,000	2,880	320	64	384
Aparejos (pack outfit)	10,000	30,000	3,333	667	4,000
Feed bags (in boxes)	10,000	1,125	140	28	168
U. S. Artillery harness	10,000	112,000	12,444	2,489	14,933
Machine-gun harness box	10,000	68,000	7,556	1,511	9,067
Total					37,441

STORED IN OPEN.

Cartridge, 30-caliber	500,000,000	500,000	83,333	16,667	100,000
Pick mattock	1,000,000	70,000	11,667	2,333	14,000
Intrenching shovels	1,000,000	140,000	23,333	4,667	28,000
Wire cutters (American)	1,000,000	8,000	1,333	267	1,600
Helmets	1,000,000	207,000	34,500	6,900	41,400
Oil (gallons)	1,000,000	200,000			40,000
Total					225,000

TABLE VI.—*Space and quality of storage required for engineer depot for 30 days' supply for 1,000,000 men.*

	Square feet.	Warehouse requirements.			
		For under 60 days.		For over 60 days.	
		Piled on—	Piled in—	Piled on—	Piled in—
Machine shop and foundry	100,000	Ground	House	Ground	House.
Rail and forestry supplies	25,000	...do	...do	...do	Do.
Camouflage and electric supplies	25,000	...do	Shed	...do	Do.
Water supply	25,000	...do	...do	...do	Do.
Pioneer	25,000	...do	...do	...do	Do.
Searchlight	25,000	...do	...do	...do	Do.
Total	225,000				
Miscellaneous	5,000,000	...do	Open	...do	Open.

TABLE VII.—*Storage requirements for 30 days' supply for 1,000,000 men.*

[NOTE.—The requirements are dependent upon how long supplies remain stationary—i. e., some supplies do not require covered storage if they are to move within a month or two—so requirements are shown under two headings, viz, maximum and minimum. Requirements for various numbers of men and various times can by computed by taking the proper proportion of items in this table.]

	Maximum covered.		Minimum covered.	
	Covered.	Open.	Covered.	Open.
QUARTERMASTER.	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*
Sack	125,000		125,000	
Package	250,000		200,000	50,000
Canned	400,000			400,000
Miscellaneous subsistence	250,000		125,000	125,000
Clothing	575,000		325,000	250,000
Salvage	100,000		50,000	50,000
Animal transportation		500,000		500,000
Animal transportation, acc.	100,000		50,000	50,000
Oats	75,000		75,000	
Hay		150,000		150,000
Miscellaneous	250,000	1,000,000	125,000	1,125,000
Total	2,125,000	1,650,000	1.075,000	2,700,000
ORDNANCE.				
Personal equipment	275,000		150,000	125,000
Horse equipment	50.000		25,000	25,000
Salvage	50.000		25,000	25,000
Small arms, ammunition, helmets, etc		250.000		250,000
Miscellaneous		200.000		200,000
Total	375.000	450.000	200,000	625,000
MEDICAL.				
Surgical supplies	25.000		25,000	
Drug sundries	100.000		25.000	75,000
Bedding, linen, etc	50.000		50.000	
Issue house	25.000		25.000	
Furniture, fixtures, etc	25.000			25,000
Iron beds, sterilizers, etc		250,000		250,000
Miscellaneous	75.000	200.000	25.000	250.000
Total	300.000	450.000	130.000	600.000
SIGNAL.				
Electrical appliances, small hardware	75.000		50.000	25.000
Cable, poles, animal-drawn transportation		750.000		750.000
Total	75.000	750.000	50.000	775,000
ENGINEER.				
Machine shops, etc	100.000			100.000
Engineer supplies	125.000	5.000.000	50.000	5.075.000
Total	225.000	5.000.000	50.000	5,175,000

SUMMARY OF ABOVE WITH ADDITIONS.

Quartermaster	2.125.000	1.650.000	1.075.000	2.700.000
Ordnance	375.000	450.000	200.000	625.000
Medical	300.000	450.000	150.000	600.000
Signal	75.000	750.000	50.000	775.000
Engineer	225.000	5.000.000	50.000	5.175.000
[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	

[illegible]

INDEX TO PLATES.

	Plate.
Typical layouts for camps	1
Camp layout, Le Mans	2
Four-man bunk	3
Type B Barrack—Lumber	4-5
Type C Barrack—Corrugated iron.	6
Demountable barrack—Dodon	7-9
Demountable barrack—Adrian	10-13
Knockdown barrack	14-16
Demountable hut—Sykes	17-19
Nissen hut—Metal	20-23
Mess hall, 40 by 160 feet	24
Mess hall—Brest	25
Brick range	26
Shower bath	27
Latrines—French and American	28
Hospital at Bazoilles	29
Hospital at Beaune	30
Base hospital—Layout A	31
Base hospital—Layout B	32
Base hospital—Layout C	33
Base hospital—Ward 20 by 164 feet.	34
Base hospital—Ward 36 by 156 feet.	35
Base hospital—Administration building	36
Base hospital—Nurses' quarters	37
Base hospital—Nurses' dining room and kitchen	38
Base hospital—Officers' quarters dining room	39-40
Base hospital—Receiving and evacuating	41
Base hospital—Receiving and evacuating and bath	42
Base hospital—Patients' bath	43
Base hospital—Latrines and bath	44
Base hospital—Recreation hall	45-46
Base hospital—Nurses' club	47
Base hospital—Laboratory and morgue	48
Base hospital—Operating and X-ray	49
Base hospital—Operating, X-ray, and clinic	50
Base hospital—Dispensary and clinic	51
Base hospital—Clinic and surgical dressings	52
Base hospital—Patients' kitchen	53
Base hospital—Kitchen and dining halls	54
Base hospital—Patients' dining room	55
Base hospital—Quartermaster stores	56
Base hospital—Quartermaster medical stores	57
Base hospital—Barracks	58
Base hospital—Personnel dining hall	59
Base hospital—Medical storehouse.	60
Base hospital—Disinfector	61
Base hospital—Ablution building.	62
Base hospital—Latrine and feces destructor	63
Base hospital—Incinerator	64
Base hospital—Electric-light plant.	65
Base hospital—Typical barrack	66
Base hospital—Disinfector, new type	67
Base hospital—Miscellaneous details	68-69
Base hospital—Horsefall destructor.	70
Base hospital—Electric wiring	71-83
Base hospital—Central administration	84
Base hospital—Central laboratory.	85
Base hospital—Central garage	86-87
Base hospital—Central officers' club	88
Base hospital—Central nurses' club	89
Base hospital—Water lines	90
Base hospital—Sewers	91
Base hospital—Bill of material, 36-foot building	92
Plumbing material	92a
Base hospital—Feces destructor	93
Base hospital—Chapel	94
Hospital demountable barrack—Type C	95-99
Camp hospital—Layout	100

Plate.
Camp hospital—Ward 101
Camp hospital—Administration building 102
Camp hospital—Patients' mess 103
Camp hospital—Bath and disinfector 104
Camp hospital—Operating and clinic 105
Camp hospital—Latrine 106
Camp hospital—Feces destructor 107
Camp hospital—Storeroom and mess 108
Camp hospital—Personnel barrack 109
Camp hospital—Latrine details 110
Camp hospital—Feces destructor 111
Camp hospital—Sewers 112
Camp hospital—Water mains 113
Camp hospital—Electric wiring 114–117
Veterinary hospital and remount depot 118
Horse shelter 119–120
Horse dip 121
Aeroplane assembly plant 122
Aeroplane depot 123
Hangar, steel, 110 by 100 feet 124–127

Plate.
Hangar, steel, 66 by 100 feet 128–131
Montoir Dock 132–136
Terminal yards at Bassens Dock 137
General depot—Gièvres 138
Engine terminal 139
Ashpit 140
Inspection pit 141
Coaling facility 142
Engine house 143
Water tank 144
Regulating station and advance depot 145
Regulating station—[illegible]-Les [illegible] 146
Rail head—Sorcy 147
Intermediate ammunition depot—[illegible] 148
Intermediate ammunition depot—[illegible] 149
Advance ammunition depot 150
Bomb and grenade depot 151
General depot—Montierchaume 152–153
Warehouse—Type B 154
Warehouse—Type C 155
Refrigerating plant 156–159

Year	Month	Element	Dates	Station
1922	Oct. 1 to Dec. 31	1st Battalion and Hq. & Serv. Platoon.		Inactive.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Do.
1923	Jan. 1 to May 31	1st Battalion less Company C and Hq. & Serv. Platoon.		Limay, Bataan, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	June	1st Battalion less Company C and Hq. & Serv. Platoon.	1-10	Limay, Bataan, P. I.
			11-30	Fort William McKinley, P. I.
		Hq. & Serv. Platoon and Company C.	1-30	Do.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	July 1 to Dec. 31	1st Battalion and Hq. & Serv. Platoon.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
1924	January	1st Battalion and Hq. & Serv.	1- 9	Fort William McKinley, P. I.
			9-31	Mariveles, Bataan, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	Feb. 1 to Apr. 30	1st Battalion and Hq. & Serv. Platoon.		Mariveles, Bataan, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	May	1st Battalion and Hq. & Serv. Platoon.	1- 9	Mariveles, Bataan, P. I.
			10-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	June	1st Battalion and Hq. & Serv. Platoon.	1-30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and 1 Battalion section of Hq. & Serv. Company.		Inactive.
	July	1st Battalion and Hq. & Serv. Platoon.	1-16	Fort William McKinley, P. I.
		1st Battalion and Hq. & Serv. Company.	17-31	Do.
		Regiment less 1st Battalion and Hq. & Serv. Platoon.	1-16	Inactive.

NOTE.—The Hq. & Serv. Platoon, 1st Battalion 14th Engineers (P. S.) changed to Hq. & Serv. Company, 14th Engineers (P. S.) July 16, 1924, in accordance with War Department Circular No. 39, 1924—Organized in accordance with columns 6, 7, and 8, table 466 P. & W.

		Regiment less 1st Battalion and Hq. & Serv. Platoon.	17-31	Inactive.
	Aug. 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	November	1st Battalion	1-16	Fort William McKinley, P. I.
			17-30	Paysavan, Bataan, P. I.
		Hq. & Serv. Company	1-30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	Dec. 1	1st Battalion		Paysavan, Bataan, P. I.
	to	Hq. & Serv. Company		Fort William McKinley
1925	Feb. 28	Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	March	1st Battalion	1-24	Paysavan, Bataan, P. I.
			25-31	Fort William McKinley, P. I.
		Hq. & Serv. Company	1-31	Do.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	Apr. 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	November	1st Battalion less Company C	1-30	Fort William McKinley, P. I.
		Company C	1- 9	Do.
			10-30	Alasasin Point, Bataan, P. I.
		Hq. & Serv. Company	1-30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.

Year	Month	Element	Dates	Station
1925	December	1st Battalion less Company C	1-31	Fort William McKinley, P. I.
		Company C	1-19	Alasasin Point, Bataan, P. I.
			20-31	Fort William McKinley, P. I.
		Hq. & Serv. Company	1-31	Do.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
1926	January	1st Battalion less Company B	1-17	Fort William McKinley, P. I.
			18-27	Maneuvers.
			28-31	Fort William McKinley, P. I
		Company B	1- 4	Do.
			5-31	Alasasin Point, Bataan, P. I.
		Hq. & Serv. Company	1-17	Fort William McKinley, P. I.
			18-27	Maneuvers
			28-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	February	1st Battalion (less Companies A and B) and Hq.& Serv Company.	1-28	Fort William McKinley, P. I.
		Company A	1-19	Do.
			20-28	Alasasin Point, Bataan, P. I.
		Company B	1-20	Do.
			21-28	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	March	1st Battalion (less Company A) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1-31	Alasasin Point, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	April	1st Battalion (less Company A) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company A	1-13	Alasasin Point, Bataan, P. I.
			14-30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	May 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	November	1st Battalion (less Company A) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company A	1	Do.
			2-30	Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	December	1st Battalion (less Company A) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1-24	Bataan, P. I.
			25-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
1927	January	1st Battalion (less Company C) and Hq. & Serv. Company.	1- 4	Fort William McKinley, P. I.
			5-19	Maneuvers.
			20-31	Fort William McKinley, P. I.
		Company C	1- 4	Do.
			5-31	Limay, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	February	1st Battalion (less Companies A and C) and Hq. & Serv. Company.	1-28	Fort William McKinley, P. I.
		Company A	1-23	Do.
			24-28	Camp Eldridge, Los Banos, P. I.
		Company C	1-28	Limay, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	March	Headquarters 1st Battalion and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1-31	Camp Eldridge, Los Banos, Laguna, P. I.
		Company B	1- 4	Fort William McKinley, P. I.
			5-31	Orani, Bataan, P. I.
		Company C	1- 5	Limay, Bataan, P. I.
			6-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	April	1st Battalion (less Companies A and B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company A	1-30	Camp Eldridge, Los Banos, Laguna, P. I.
		Company B	1-30	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.

Year	Month	Element	Dates	Station
1927	May	1st Battalion (less Companies A and B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1-31	Camp Eldridge, Los Banos, Laguna, P. I.
		Company B	1-5	Orani, Bataan, P. I.
			6-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	June	1st Battalion (less Company A) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company A	1-19	Camp Eldridge, Los Banos, Laguna, P. I.
			20-30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	July 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	November	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1-27	Do.
			28-30	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	December	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-31	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
1928	January	1st Battalion (less Company B) and Hq. & Serv. Company.	1- 7	Fort William McKinley, P. I.
			8-23	Maneuvers.
			24-31	Fort William McKinley, P. I.
		Company B	1-31	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	Feb. 1 to Apr. 30	1st Battalion (less Company B) and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Company B	--------	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	May	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-13	Orani, Bataan, P. I.
			14-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	June 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	November	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1	Do.
			2-30	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	Dec. 1 to Mar. 31	1st Battalion (less Company B) and Hq. & Serv. Co.	--------	Fort William McKinley, P. I.
1929		Company B	--------	Orani, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	April	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1-24	Orani, Bataan, P. I.
			25-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	May 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	November	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1	Do.
			2-30	Olongapo, Zambales, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	December	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-31	Olongapo, Zambales, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.

Year	Month	Element	Dates	Station
1930	January	1st Battalion (less Company B) and Hq. & Serv. Company.	1- 8	Fort William McKinley, P. I.
			9-16	Maneuvers.
			17-31	Fort William McKinley, P. I.
		Company B	1-31	Olongapo, Zambales, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	Feb. 1 to Apr. 30	1st Battalion (less Company B) and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Company B	--------	Olongapo, Zambales, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	May	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-28	Olongapo, Zambales, P. I.
			29-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	June	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1- 2	Quartermaster's Barracks, Manila, P. I.
			3-30	Gumaca, Tayabas, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	July 1 to Nov. 30	1st Battalion (less Company B) and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Company B	--------	Gumaca, Tayabas, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	December	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1	Gumaca, Tayabas, P. I.
			2-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
1931	January	1st Battalion (less Company B) Hq. & Serv. Company.	1- 3	Fort William McKinley, P. I.
			4-15	Maneuvers.
			16-20	Fort William McKinley, P. I.
			21-30	Maneuvers.
			31	Fort William McKinley, P. I.
		Company B	1-31	Do.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	February	1st Battalion (less Company B) and Hq. & Serv. Company.	1-28	Fort William McKinley, P. I.
		Company B	1- 2	Do.
			3-28	Gumaca, Tayabas, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	March	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-31	Gumaca, Tayabas, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	April	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1-10	Gumaca, Tayabas, P. I.
			11-30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	May 1 to Oct. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	November	1st Battalion (less Company B) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company B	1- 2	En route to Bongabong, Nueva Ecija, P. I.
			3-30	Bongabong, Nueva Ecija, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	December	1st Battalion (less Company B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-31	Bongabong, Nueva Ecija, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Co.	--------	Inactive.
1932	January	1st Battalion (less Company B) and Hq. & Serv. Company.	1- 7	Fort William McKinley, P. I.
			8-21	Maneuvers.
			22-31	Fort William McKinley, P. I.
		Company B	1-31	Bongabong, Nueva Ecija, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.

Year	Month	Element	Dates	Station
1932	Feb. 1 to Sept. 30.	1st Battalion (less Company B) and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Company B		Bongabong, Nueva Ecija, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	October	1st Battalion (less Companies B and C) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company B	1-31	Bongabong, Nueva Ecija, P. I.
		Company C	1-27 28-31	Fort William McKinley, P. I. Fort Mills, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	November	1st Battalion Headquarters and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company A	1- 3 4-24 25-30	Do. Limay, Bataan, P. I. Fort William McKinley, P. I.
		Company B	1-30	Bongabong, Nueva Ecija, P. I.
		Company C	1-30	Fort Mills, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	Dec. 1 to	1st Battalion (less Companies B and C) and Hq. & Serv. Company.		Fort William McKinley, P. I.
1933	Aug. 31	Company B		Bongabong, Nueva Ecija, P. I.
		Company C		Fort Mills, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	September	1st Battalion (less Company C) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company C	1-30	Fort Mills, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	October	1st Battalion (less Company C) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company C	1 2-31	Fort Mills, P. I. Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	Nov. 1 to Dec. 31.	1st Battalion and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
1934	January	1st Battalion Headquarters and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1- 4 5 6-12 13-31	Do. Limay, Bataan, P. I. Catmon Camp, Bataan, P. I. Fort William McKinley, P. I.
		Company B	1-31	Bongabong, Nueva Ecija, P. I.
		Company C	1-31	Fort Mills, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	February	1st Battalion (less Company A) and Hq. & Serv. Company.	1- 4 5-22 23-28	Fort William McKinley, P. I. Maneuvers. Fort William McKinley, P. I.
		Company A	1- 4 5-22 23-28	Do. Limay, Bataan, P. I. Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	Mar. 1 to July 31.	1st Battalion and Hq. & Serv. Company.		Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	August	1st Battalion (less Company C) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company C	1- 8 9-31	Do. Fort Mills, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	September	1st Battalion (less Company C) and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Company C	1-30	Fort Mills, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.
	October	1st Battalion (less Company C) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company C	1-10 11-31	Fort Mills, P. I. Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.		Inactive.

Year	Month	Element	Dates	Station
1934	November	1st Battalion and Hq. & Serv. Company.	1-30	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	December	1st Battalion (less Company C) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company C	1-11	Do.
			12-24	Manila, P. I. (Military Tournament).
			25-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
1935	January	1st Battalion (less Company A) and Hq. & Serv. Company.	1-23	Fort William McKinley, P. I.
			24-31	Mariveles, Bataan, P. I.
		Company A	1- 6	Fort William McKinley, P. I.
			7-18	Manila, P. I.
			19-23	Fort William McKinley, P. I.
			24-31	Mariveles, Bataan, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	February	1st Battalion (less Company A) and Hq. & Serv. Company.	1-18	Maneuvers, area of Mariveles, Bataan, P. I.
			19-28	Fort William McKinley, P. I.
		Company A	1-18	Maneuvers, area of Mariveles, Bataan, P. I.
			19-24	Fort William McKinley, P. I.
			25-28	Nichols Field, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	Mar. 1 to Apr. 30	1st Battalion (less Company A) and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Company A	--------	Nichols Field, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	May	1st Battalion (less Company A) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Company A	1-25	Nichols Field, P. I.
			26-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	June 1 to Dec. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
1936	January	1st Battalion and Hq. & Serv. Company.	1- 7	Fort William McKinley, P. I.
			8-31	Maneuvers.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	February	1st Battalion and Hq. & Serv. Company.	1-17	Maneuvers.
			18-29	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	Mar. 1 to Dec. 31	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
1937	January	1st Battalion and Hq. & Serv. Company.	1- 3	Fort William McKinley, P. I.
			4-27	Maneuvers, Mariveles, Bataan, P. I.
			28-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	Feb. 1 to Nov. 30	1st Battalion and Hq. & Serv. Company.	--------	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.
	December	1st Battalion (less Companies A and B) and Hq. & Serv. Company.	1-31	Fort William McKinley, P. I.
		Companies A and B	1- 9	Do.
			10-14	Maneuvers.
			15-31	Fort William McKinley, P. I.
		Regiment less 1st Battalion and Hq. & Serv. Company.	--------	Inactive.

SIXTEENTH ENGINEERS (RAILWAY BATTALION)

The Sixteenth Engineers (Railway Battalion) consisting of Headquarters and Supply Platoon and Companies A, B, and C, was organized January 27, 1921, at Engineer Barracks No. 2 adjacent to the Coblenz Bahnhof, by transfers from Company "B," 1st Engineers, under authority of the Act of Congress approved June 4, 1920, and pursuant to Adjutant General's letter 320, Germany (Miscl. Div.) CCW AMSI-158-0, dated November 9, 1920.

Year	Month	Element	Dates	Station
1921	January	Battalion	27-31	Coblenz, Germany.
	February	do	1-28	Do.
	March	Battalion less Company A	1-31	Do.
		Company A	1-30	Do.
			31	Kreuzberg, Germany.
	Apr. 1 to May 31	Battalion less Company A		Coblenz, Germany.
		Company A		Kreuzberg, Germany.
	June 1 to Oct. 31	Battalion less Companies A and B.		Coblenz, Germany.
		Company A		Kreuzberg, Germany.
		Company B		Kottenheim, Germany.
	November	Company A	1-30	Coblenz, Germany.
		Battalion less Company A [32]		Inactive.
	December	Company A	1-31	Coblenz, Germany.
		Battalion less Company A		Inactive.
1922	January	Company A	1-15	Coblenz, Germany.
			16-31	Kreuzberg, Germany.
		Battalion less Company A		Inactive.
	Feb. 1 to Mar. 31	Company A		Kreuzberg, Germany.
		Battalion less Company A		Inactive.
	April	Company A	1-	Kreuzberg, Germany.
			-30	Coblenz, Germany.
		Battalion less Company A		Inactive.
	May 1 to Oct. 31	Company A		Coblenz, Germany.
		Battalion less Company A [33]		Inactive.
1924	Nov. 1 to Apr. 8	Battalion [34]		Do.

---

[32] Under authority of A. G. letter 320.2 Engineer Corps (Misc. Div.) dated Aug. 25, 1921—C. E. file 320-P-80, and pursuant to G. O. No. 90, Headquarters, American Forces in Germany, 1921, the 16th Engineers (Railway Battalion) less Company A, was made inactive.

[33] Under authority of letter A. G. 320.2 (7-15-22) (Miscl. Div.) M-3, dated July 18, 1922, C. E. file 320.2 (Engineers, Corps of) P-523, and pursuant to G. O. No. 75, Headquarters, American Forces in Germany, dated Oct. 18, 1922, Company A, 16th Engineers was made inactive Oct. 31, 1922, and the personnel transferred to the 1st Engineers.

[34] The 16th Engineer Battalion (Railway) (inactive) was demobilized under authority of letter A. G. 320.2 (4-3-24) (Misc.) M-C, dated Apr. 8, 1924—C. E. file 320.2-P-854.

SEVENTEENTH ENGINEER BATTALION (TOPOGRAPHICAL)

The Seventeenth Engineer Battalion (Topographical) less one surveying company organized at Camp A. A. Humphreys, Va., under authority of Adjutant General's letter 320.2 Engr. Corps (Misc. Div.) dated August 25, 1921–C. E. file 320–P–80.

Year	Month	Element	Dates	Station
1921	Sept. 1 to Dec. 31	Headquarters		Camp A. A. Humphreys, Va.
1922	January	Consolidated Detachment	1–31	Do.
	February	Battalion (Hq. & Serv. Platoon) Company A (Surveying), Company B (Reproduction).	1–28	Do.
	Mar. 1 to May 31	Battalion		Do.
	June	Battalion less Company A	1–30	Do.
		Company A	1–27	Do.
			28–30	Fort Washington, Md.
	July 1 to Aug. 31	Battalion less Company A		Camp A. A. Humphreys, Va.
		Company A		Fort Washington, Md.
	September	Battalion less Company A	1–30	Camp A. A. Humphreys, Va.
		Company A	1–29	Fort Washington, Md.
			30	Camp Meade, Md.
	Oct. 1 to	Battalion less Company A		Camp A. A. Humphreys, Va.
1923	May 31	Company A		Camp Meade, Md.
	June	Battalion less Company A	1–30	Fort Humphreys, Va.
		Company A	1–9	Camp Meade, Md.
			10–30	Fort Humphreys, Va.
	July	Battalion	1–18	Do.

NOTE.—Under authority of letter A. G. 322.13 (6–1–23) (Misc.) C dated July 14, 1923 (CE file 320.2 (17th Engineers) P–6), the 17th Engineers was demobilized and the personnel and records transferred to the 29th Engineers.

EIGHTEENTH ENGINEERS (LIGHT BRIDGE TRAIN)

The Eighteenth Engineers (Light Bridge Train) was organized effective October 1, 1921, from personnel of the Ninth Engineers (Mounted) en route from Sam Fordyce, Tex., to Fort Sam Houston, Tex., under authority of letter A. G. 320.2 Engr. Corps (Misc. Div.) dated August 25, 1921 (C. E. file 320–P–80).

Year	Month	Element	Dates	Station
1921	October	Train	1	Organized en route from Dolores Creek, Tex. to Fort McIntosh, Tex.
			2	Fort McIntosh, Tex.
			3–12	En route to Fort Sam Houston, Tex.
			13–31	Fort Sam Houston, Tex.
1922	Nov. 1 to Apr. 30	do		Do.
	May	do	1–20	Do.
			21	En route to Marlin, Tex.
			22–30	Camp at Marlin, Tex.
	June 1 to July 31	do		Do.
	August	do.[35]	1–11	Do.

---

[35] Placed on the inactive list on the 11th per G. O. No. 47, Headquarters 8th C. A., 1922, and pursuant to letter A. G. 320.2 (7–15–22) (Misc. Div.) M–3, dated July 18, 1922. All officers attached to the 2d Engineers and all enlisted men transferred in grade to 2d Engineers at Camp Travis, Tex. The 18th Engineers was demobilized Apr. 30, 1924, per final return and in accordance with letter A. G. 320.2 (4–3–24) (Misc.) M–O dated Apr. 8, 1924—C. E. file 320.2–P–854.

TWENTY-NINTH ENGINEERS (TOPOGRAPHIC)

The World War Twenty-ninth Engineers was organized under the provisions of the Act of Congress approved May 18, 1917. The regimental headquarters was not organized and therefore the station record set forth below is taken up by battalions. Under authority of letter A. G. 322.13 (6-1-23) C, dated July 14, 1923, the World War Twenty-ninth Engineers was reconstituted with station at Fort Humphreys, Va., on July 18, 1923.

FIRST BATTALION

(Consisting of Battalion Headquarters and Companies A, G, and H)

Year	Month	Element	Dates	Station
1917	September	Company A (Company D 25th Engineers).[36]	17-30	Camp Devens, Mass.
	October	do	1-27	Camp Devens, Mass.
			28-30	En route to Hoboken, N. J., and aboard U. S. S. *Agamemnon*.
			31	Aboard U. S. S. *Agamemnon* en route to Brest, France.
	November	Company A	1-12	En route to Brest, France.
			13-16	Brest, France (aboard ship).
			17	En route to St. Nazaire, France, by rail.
			18-31	St. Nazaire, France.
	December	do	1- 3	En route to Langres, France.
			4-31	Langres, France.
1918	Jan. 1 to Mar. 31	do		Do.
	April	do	1-30	Do.
		Company H[37]	18-30	General Headquarters, American Expeditionary Forces (Chaumont).
	May	Company A	1-31	Langres, France.
		Company H	1-31	General Headquarters, American Expeditionary Forces.
	June	Battalion Headquarters	6-30	Langres, France.
		Company A[38]	1-30	Do.
		Company H[38]	1-30	General Headquarters, American Expeditionary Forces.
	July	Battalion Headquarters, Company A.	1-31	Langres, France.
		Company G[39]	26-31	Fort, Myer, Va.
		Company H	1-31	General Headquarters, American Expeditionary Forces.
	August	Battalion Headquarters, Company A.	1-31	Langres, France.
		Company G	1-31	Fort Myer, Va.
		Company H	1-31	General Headquarters, American Expeditionary Forces.

[36] Company A was organized as Company D (Surveying and Printing), 25th Engineers, at Camp Devens, Mass., on Sept. 17, 1917, pursuant to G. O. No. 108, War Department, 1917, and memorandum from the Chief of Engineers dated Aug. 2, 1917 (ED 104494/68), Company D, 25th Engineers was redesignated Company A, 29th Engineers, for surveying and printing, per telegraphic instructions of the War Department dated Oct. 20, 1917; Company A, 29th Engineers, was assigned to the 1st Battalion, 29th Engineers per G. O. No. 84, G. H. Q., A. E. F., dated June 1, 1918, having operated as a separate company until that time.

[37] Company H, 29th Engineers, was organized at General Headquarters American Expeditionary Forces on Apr. 18, 1918, pursuant to sec. IV, G. O. No. 54, General Headquarters, American Expeditionary Forces, 1917, and assigned to the 1st Battalion, 29th Engineers, per sec. II, G. O. No. 84, General Headquarters American Expeditionary Forces, dated June 1, 1918.

[38] The Headquarters of the 1st Battalion, 29th Engineers, was organized at Langres, France, on June 6, 1918, pursuant to sec. II, G. O. No. 84, American Expeditionary Forces, 1918; Companies A and H were assigned to the 1st Battalion under the same authority.

[39] Company G (Topography and Map Reproduction), 29th Engineers, was organized at Fort Myer, Va., on July 26, 1918, pursuant to G. O. No. 108, War Department, 1917. Assigned to 1st Battalion, 29th Engineers upon arrival, at Langres, France, Oct. 31, 1918.

Year	Month	Element	Dates	Station
1918	September	Battalion Headquarters, Company A.	1-30	Langres, France.
		Company G	1-29	Fort Myer, Va.
			30	En route to Camp Merritt, N. J.
		Company H	1-30	General Headquarters, American Expeditionary Forces.
	October	Battalion Headquarters, Company A.	1-31	Langres, France.
		Company G	1- 7	Camp Merritt, N. J.
			8-20	Aboard U. S. S. *Caserta* en route from Hoboken, N. J., to Brest, France.
			21-25	Camp Pontanezen, Brest, France.
			26-30	En route to Langres, France.
			31	Langres, France.
		Company H	1-31	General Headquarters, American Expeditionary Forces.
	Nov. 1 to	Battalion Headquarters, Companies A and G.		Langres, France.
1919	May 31	Company H		General Headquarters, American Expeditionary Forces.
	June	Battalion Headquarters Companies A and G.	1-14	Langres, France.
			15-17	En route to St. Nazaire, France.
			18-23	St. Nazaire, France.
			24	Boarded U. S. S. *Mercury*.
			25-30	Aboard U. S. S. *Mercury* en route to United States.
		Company H	1-9	General Headquarters, American Expeditionary Forces.
			10	En route to Langres, France.
			11-14	Langres, France.
			15-17	En route to St. Nazaire, France.
			18-23	St. Nazaire, France.
			24	Boarded U. S. S. *Mercury*.
			25-30	Aboard U. S. S. *Mercury* en route to United States.
	July	Battalion Headquarters Companies A, G, and H.	1-5	Aboard U. S. S. *Mercury* en route to Newport News, Va.
			6-9	Camp Hill, Newport News, Va.
			10-11	Boarded U. S. S. *Yale* and arrived at Camp Upton, N. Y.
			12-13	Camp Upton, N. Y. Demobilized July 13.

SECOND BATTALION

(Consisting of Battalion Headquarters and Companies B, C, D, E, and F)

Year	Month	Element	Dates	Station
1917	December	Company B [39a]	10-31	Camp Devens, Mass.
1918	January	Company B	1-27	Do.
			28-29	En route to Hoboken, N. J., and aboard U. S. Army cargo transport *Calameres*.
			30-31	Aboard U. 3. Army cargo transport *Calameres* en route to Brest, France.
		Company C [40]	8-31	Camp Devens, Mass.
	February	Company B	1-15	Aboard U. S. Army cargo transport *Calameres* en route to Brest, France.
			16	Aboard ship at Brest, France.
			17-18	Camp Pontanezen, Brest, France.
			19-23	En route to Langres, France.
			24-28	Langres, France.
		Company C	1-28	Camp Devens, Mass.
	March	Company B	1-4	Langres, France.
			5-31	Fort de St. Menge, France.
		Company C	1-31	Camp Devens, Mass.
		Company D [41]	30-31	Do.

[39a] Company B (surveying, map reproduction, and ranging), 29th Engineers, was organized pursuant to G. O. No. 108, War Department, 1917, at Camp Devens, Mass., on Dec. 10, 1917, by the transfer of selected enlisted men of the 25th Engineers.

[40] Company C (surveying, map reproduction and ranging), 29th Engineers, was organized pursuant to G. O. No. 108, War Department, 1917, at Camp Devens, Mass., on Jan. 8, 1918, from overstrength of Company B, 29th Engineers.

[41] Company D, 29th Engineers, was organized persuant to G. O. No. 108, War Department, 1917, on Mar. 30, 1918, at Camp Devens, Mass. Designation changed to Company F, 603d Engineers, June 7, 1918, at Washigton Barracks, D. C., redesignated Company D, 29th Engineers, Aug. 17, 1918, per G. O. No. 135, G. H. Q., A. E. F., 1918.

Year	Month	Element	Dates	Station
1918	April	Company B	1–30	Fort de St. Menge, France.
		Companies C and D	1–30	Camp Devens, Mass.
	May	Company B	1–31	Fort de St. Menge, France.
		Company C	1–31	Camp Devens, Mass.
		Company D	1–26	Do.
			27–28	En route to Washington Barracks, D. C.
			29–31	Washington Barracks, D. C.
	June	Company B	1–30	Fort de St. Menge, France.
		Company C	1–20	Camp Devens, Mass.
			21	En route to pier No. 12, Brooklyn, N. Y., and aboard S. S. *Re D'Italia.*
			22–30	Aboard S. S. *Re D'Italia* en route to Brest, France.
		Company D (designation changed to Company F, 603d Engineers, June 7).	1–30	Washington Barracks, D. C.
		Company E (Company F, 604th Engineers).[42]	13–30	Do.
		Company C	1–28	Camp Devens, Mass.
	July	Company B	1–31	Langres, France (attached to 1st Battalion per sec. II, G. O. No. 84, General Headquarters, American Expeditionary Forces, 1918).
		Company C	1– 5	Aboard S. S. *Re D'Italia* en route to Brest, France.
			6– 9	Brest, France.
			10–12	En route to Langres, France.
			13–31	Langres, France.
		Company D (Company F, 603d Engineers).	1– 8	Washington Barracks, D. C.
			9–10	En route to Hoboken, N. J., and aboard S. S. *Toloa.*
			11–21	Aboard S. S. *Toloa* en route to Brest, France.
			22–24	Brest, France.
			25–28	En route to Langres, France.
			29–31	Langres, France.
		Company E (Company F, 604th Engineers).	1–31	Washington Barracks, D. C.
	August	Companies B, C, and D[43]	1–31	Langres, France.
		Company E (Company F, 604th Engineers).[44]	1–10	Washington Barracks, D. C.
			11	Enroute to Camp Stewart, Va.
			12–13	Camp Stewart, Newport News, Va.
			14–25	Aboard *Konigen Den Neder Landen* en route to Brest, France.
			26–28	Camp Pontanezen, Brest, France.
			29–30	En route to Langres, France.
		Company F (605th Engineers)[45]	2–31	Washington Barracks, D. C.
	September	Companies B, C, and D	1–30	Langres, France.
		Company E	1– 3	En route to Langres, France.
			4–13	Langres, France.
			14–30	Fort St. de Menge, France.
		Company F	1–19	Washington Barracks, D. C.
			20	En route to Camp Merritt, N. J.
			21–23	Camp Merritt, N. J.
			24	En route to Hoboken, N. J., and boarded S. S. *Teucer.*
			25–30	Aboard S. S. *Teucer* en route to Liverpool, England.
1918	October	Battalion Headquarters[46]	10–31	Toul, France.
		Companies B, C, and D	1– 4	Langres, France.
			5–31	Toul, France.

---

[42] Company E, 29th Engineers, was organized pursuant to G. O. No. 108, War Department, 1917, at Washington Barracks, D. C., as Company F, 604th Engineers, by transfers from Company F, 603d Engineers (formerly Company D, 29th Engineers), on June 13, 1918. Company F, 604th Engineers, redesignated Company E, 29th Engineers, Aug. 17, 1918, per G. O. No. 135, G. H. Q., A. E. F., 1918.

[43] Company B relieved from attachment to 1st Battalion; Company C assigned to 2d Battalion; and Company F, 603d Engineers, redesignated Company D, 29th Engineers, per G. O. No. 135, G. H. Q., A. E. F., dated Aug. 17, 1918.

[44] Designation changed from Company F, 604th Engineers, to Company E, 29th Engineers, per G. O. No. 135, G. H. Q., A. E. F., Aug. 17, 1918.

[45] Company F, 29th Engineers, organized pursuant to G. O. No. 108, War Department, 1917, as Company F, 605th Engineers, Aug. 2, 1918, at Washington Barracks, D. C. Redesignated Company F, 29th Engineers, per sec. III, G. O. No. 135, G. H. Q., A. E. F., dated Aug. 17, 1918.

[46] Headquarters 2d Battalion, 29th Engineers, organized Oct. 10, 1918, at Toul, France, pursuant to G. O. No. 135, G. H. Q., A. E. F., 1918.

Year	Month	Element	Dates	Station
1918	October	Company E	1–18	Fort St. de Menge, France.
			19–31	Toul, France.
		Company F	1– 7	Aboard S. S. *Teucer* en route to Liverpool, England.
			8	En route to Winnall Downs, Winchester, England.
			9–10	Winnall Downs, Winchester, England.
			11	En route to Southampton, England, and boarded S. S. *S. W. Miller* en route to Le Havre.
			12	Arrived at Le Havre, France.
			13–16	En route to Langres, France.
			17–31	Langres, France.
	November	Battalion Headquarters, Companies C and E.	1–30	Toul, France.
		Companies B and D	1–27	Do.
			28–30	Jean D'Arc Barracks, France.
		Company F	1–30	Langres, France.
	December	Battalion Headquarters, Company C.	[47] 1–10	Toul, France.
		Companies B, D, and E	1–10	Jean D'Arc Barracks, France.
		Company F	1–10	Fort St. De Menge, France.

---

[47] The 2d Battalion, 29th Engineers, was redesignated the 1st Battalion, 74th Engineers on Dec. 10, 1918, per GO No. 221, GHQ, AEF, 1918, as follows:

Designation	*Redesignation*
Headquarters, 2d Battalion, 29th Engineers	Headquarters, 1st Battalion, 74th Engineers.
Company F, 29th Engineers	Company A, 74th Engineers.
Company B, 29th Engineers	Company B, 74th Engineers.
Company C, 29th Engineers	Company C, 74th Engineers.
Company D, 29th Engineers	Company D, 74th Engineers.
Company E, 29th Engineers	Company E, 74th Engineers.

THIRD BATTALION

(Consisting of Battalion Headquarters, and Companies I, K, and L—Battalion Headquarters and Company L were not organized)

Year	Month	Element	Dates	Station
1918	September	Company I[48]	19–30	Neufchateau, Vosges, France.
	October	Company I	1–31	Do.
		Company K[49]	4–30	Fort Myer, Va.
	November	Company I	1–31	Neufchateau, Vosges, France.
		Company K	1–20	Fort Myer, Va.
			21–30	Camp Leach, D. C.
	December	Company I	1–23	Neufchateau, Vosges, France.
			24–31	Langres, France (attached to 1st Battalion).
		Company K	1–31	Camp Leach, D. C.
1919	January	Company I	1–31	Langres, France (attached to 1st Battalion).
		Company K[50]	1– 2	Camp Leach, D. C.
	Feb. 1 to May 31	Company I		Langres, France (attached to 1st. Battalion).
	June	do	1–14	Do.
			15–17	En route to St. Nazaire, France.
			18–23	St. Nazaire, France.
			24	Boarded U. S. S. *Mercury*.
			25–30	En route to United States (attached to 1st Battalion).
	July	do	1– 5	Aboard U. S. S. *Mercury* enroute to Newport News, Va. (attached to 1st Battalion).
			6– 9	Camp Hill, Newport News, Va. (attached to 1st Battalion).
			10–11	Boarded U. S. S. *Yale* and arrived Camp Upton, N. Y. (attached to 1st Battalion).
			12–13	Camp Upton, N. Y. (attached to 1st Battalion). Demobilized July 13.

---

[48] Company I (surveying and printing), 29th Engineers, was organized at Neufchateau, Vosges, France, on Sept. 19, 1918, under authority of G. O. No. 131, G. H. Q., A. E. F., 1918, by transfers from other companies of the 29th Engineers.

[49] Company K, 29th Engineers, was organized at Fort Myer, Va., on Oct. 4, 1918, under the provisions of the act of Congress approved May 18, 1917, and pursuant to War Department General Order No. 108, 1917.

[50] Company K demobilized 2d per letter Chief of Engineers 370.01 dated Nov. 30, 1918.

FOURTH BATTALION

(Consisting of Battalion Headquarters and Companies M, N, O, and P—Battalion Headquarters and Companies N, O, and P were not organized. Consideration was being given to the organization of Companies N, O, and P at Camp A. A. Humphreys, Va., but the signing of the Armistice precluded their actual organization.)

Year	Month	Element	Dates	Station
1918	November	Company M [51]	14–30	Toul, France.
	December	do	1–31	Do.
1919	January	do	1–20	Do.
			21	En route to Langres, France.
			22–31	Langres, France (attached to 1st Battalion).
	Feb. 1 to Apr. 30	do		Do.
	May	do	1–7	Do.
			8	Transferred to 3d Army, Coblenz, Germany.
			9–31	Coblenz, Germany.
	June 1 to July 31	do		Do.
	August	do	1–3	Do.
			4–7	En route to Camp Pontanezen, Brest, France.
			8	Camp Pontanezen, Brest, France.
			9	Boarded U. S. S. *Troy.*
			10–20	Aboard U. S. S. *Troy* en route to Brooklyn, N. Y.
			21–24	On pier No. 3, Hoboken, N. J.
			25–26	En route to Camp A. A. Humphreys, Va.
			27–31	Camp A. A. Humphreys, Va.
	September	do	1–2	Do.
				Demobilized Sept. 2.

---

[51] Company M (surveying and printing) was organized on Nov. 14, 1918, pursuant to sec. II, G. O. No. 182. G. H. Q., A. E. F., 1918, at Toul, Meruthe et Moselle, France, by transfers of surplus personnel from Headquarters, 1st Battalion, 29th Engineers per S. O. No. 338, G. H. Q., A. E. F., 1918.

TWENTY-NINTH ENGINEER BATTALION (TOPOGRAPHIC)

Under authority of letter A. G. 322.13 (6–1–23) (Misc.) C, dated July 14, 1923, (C. E. 320.2 (17th Engrs.) P 6), the World War Twenty-ninth Engineers was reconstituted on the active list at Fort Humphreys, Va., by transfer of personnel and records from the Seventeenth Engineers on July 18, 1923.

Year	Month	Element	Dates	Station
1923	July	Battalion Headquarters Hq. & Serv. Platoon.	18-31	Fort Humphreys, Va.
		Company A		Do.
		Company B		Do.
  1924	Aug. 1 to Mar. 31	Battalion		Do.
	April	Battalion Headquarters, H. & Serv. Platoon.	1-30	Do.
		Company A		Do.
		Company C [52]		Do.
  1925	May 1 to June 30	Battalion		Do.
  1926	July 1 to Oct. 31	Battalion less Company B		Do.
		Company B		Inactive.
	November	Battalion less Company B	1-30	Fort Humphreys, Va.
		Company B [53]	1-14	Inactive.
			15-30	Fort Sam Houston, Tex.
  1929	Dec. 1 to June 30	Battalion less Company B		Fort Humphreys, Va.
		Company B		Fort Sam Houston, Tex.
	July	Battalion less Company B	1- 2	En route to Camp Dix, N. J.
			3-31	Camp Dix, N. J.
		Company B	1-31	Fort Sam Houston, Tex.
	August	Battalion less Company B	1-29	Camp Dix, N. J.
			30-31	En route to Fort Humphreys, Va.
		Company B	1-31	Fort Sam Houston, Tex.
	September	Battalion less Company B	1-30	Fort Humphreys, Va.
		Company B	1-30	Fort Sam Houston, Tex.
	October	Battalion less companies B and C.	1- 9	Fort Hmphreys, Va.
			9-12	Enroute to Brooklyn, N. Y.
			13-15	Army Base, Brooklyn, N. Y.
			15	Assigned to Special Engineer Battalion in Nicaragua. Hq. & Serv. Platoon, 29th, forming Hq. & Serv. Platoon Special Nicaraguan Survey Battalion and Company A—29th being Company B, Special Nicaraguan Survey Battalion—See 370 (Nicaragua Canal), 68.
		Company B	1-31	Fort Sam Houston, Tex.
		Company C	1-21	Fort Humphreys, Va.
			22-31	Army War College, Washington, D. C.
  1930	Nov. 1 to May 31	Battalion less Companies B and C.		With Nicaraguan Survey Battalion.
		Company B		Fort Sam Houston, Tex.
		Company C		Army War College, Washington, D. C.
	June	Battalion less Companies B and C.	1-30	With Nicaraguan Survey Battalion.
		Company B	1-21	Fort Sam Houston, Tex.
			22-27	En route to Mitchel Field, Long Island, N. Y.
			28-30	Mitchel Field, Long Island, N. Y.
		Company C	1-30	Army War College, Washington, D. C.

---

[52] Designation of Company B changed to Company C per War Department G. O. 38, 1923 (1-26-24).

[53] Company B reconstituted on active list at Fort Sam Houston, Tex., the personnel of Company E, 2d Engineers, being transferred thereto.

Year	Month	Element	Dates	Station
1930	July	Battalion less Companies B and C.	1-31	With Nicaraguan Survey Battalion.
		Company B	1-31	Mitchel Field, Long Island, N. Y.
		Company C	1-31	Army War College, Washington, D. C.
	August	Battalion less Companies B and C.	1-31	With Nicaraguan Survey Battalion
		Company B	1-23	Mitchel Field, Long Island, N. Y.
			24-31	Camp Dix, N. J.
		Company C	1-31	Army War College, Washington, D. C.
	September	Battalion less Companies B and C.	1-30	With Nicaraguan Survey Battalion.
		Company B	1-12	Camp Dix, N. J.
			13-30	Mitchel Field, Long Island, N. Y.
		Company C	1-30	Army War College, Washington, D. C.
	Oct. 1	Battalion less Companies B and C.		With Nicaraguan Survey Battalion.
	to	Company B		Mitchel Field, Long Island, N. Y.
1931	June 30	Company C		Army War College, Washington, D. C.
	July	Battalion less Companies B and C.	1-25	With Nicaraguan Survey Battalion.
			26-27	Army Base, Brooklyn, N. Y.
			28-31	Fort Schuyler, N. Y.
		Company B	1-31	Mitchel Field, Long Island, N. Y.
		Company C	1-31	Army War College, Washington, D. C.
	August	Battalion less Companies B and C.	1-31	Fort Schuyler, N. Y.
		Company B	1-31	Mitchel Field, Long Island, N. Y.
		Company C	1-31	Army War College, Washington, D. C.
	September	Battalion less Companies B and C.	1-12	Fort Schuyler, N. Y.
			13-29	Camp Dix, N. J.
			30	Fort Schuyler, N. Y.
		Company B	1-10	Mitchel Field, Long Island, N. Y.
			11-30	Camp Dix, N. J.
		Company C	1-30	Army War College, Washington, D. C.
	Oct 1	Battalion less Companies B and C.		Fort Schuyler, N. Y.
	to	Company B		Mitchel Field, Long Island, N. Y.
1932	Apr. 30	Company C		Army War College, Washington, D. C.
	May	Headquarters, Hq. & Serv. Platoon.	1-31	Fort Schuyler, N. Y.
		Company A	1-25	Do.
			26-31	Blauvelt, N. Y.
		Company B	1-31	Mitchel Field, Long Island, N. Y.
		Company C	1-31	Army War College, Washington, D. C.
	June 1 to Aug. 31	Headquarters, Hq. & Serv. Platoon.		Fort Schuyler, N. Y.
		Company A		Blauvelt, N. Y.
		Company B		Mitchel Field, Long Island, N. Y.
		Company C		Army War College, Washington, D. C.
	September	Headquarters, Hq. & Serv. Platoon.	1-30	Fort Schuyler, N. Y.
		Company A	1-10	Blauvelt, N. Y.
			11-30	Fort Schuyler, N. Y.
		Company B	1-12	Mitchel Field, Long Island, N. Y.
			13-30	Raritan Arsenal, N. J.
		Company C	1-30	Army War College, Washington, D. C.
	October	Headquarters, Hq. & Serv. Platoon.	1-31	Fort Schuyler, N. Y.
		Company A	1-19	Do.
			20-31	Scarsborough, N. Y.
		Company B	1-18	Raritan Arsenal, N. J.
			19-23	En route to Pine Camp, N. Y.
			24-31	Pine Camp, N. Y.
		Company C	1-31	Army War College, Washington, D. C.
	November	Headquarters, Hq. & Serv. Company.	1-30	Fort Schuyler, N. Y.
		Company A	1-30	Ossining, N. Y.
		Company B	1-21	Pine Camp, N. Y.
			22-24	En route to Raritan Arsenal, N. J.
			25-30	Raritan Arsenal, N. J.
		Company C	1-30	Army War College, Washington, D. C.

Year	Month	Element	Dates	Station
1932 1933	Dec. 1 to Mar. 31	Headquarters, Hq. & Serv. Company.		Fort Schuyler, N. Y.
		Company A		Ossining, N. Y.
		Company B		Raritan Arsenal, N. J.
		Company C		Army War College, Washington, D. C.
	April	Headquarters, Hq. & Serv. Company.	1-30	Fort Schuyler, N. Y.
		Company A	1-30	Ossining, N. Y.
		Company B	1-16	Raritan Arsenal, N. J.
			17-20	En route to Pine Camp, N. Y.
			21-30	Pine Camp, N. Y.
		Company C	1-30	Army War College, Washington, D. C.
	May	Headquarters, Hq. & Serv. Company.	1-31	Fort Schuyler, N. Y.
		Company A	1- 4	Ossining, N. Y.
			5-31	Bedford, N. Y.
		Company B	1-31	Pine Camp, N. Y.
		Company C	1-31	Army War College, Washington, D. C.
	June	Headquarters, Hq. & Serv. Company.	1-30	Fort Schuyler, N. Y.
		Company A	1-30	Bedford, N. Y.
		Company B	1- 3	En route to Raritan Arsenal, N. J.
			4-30	Raritan Arsenal, N. J.
		Company C	1-30	Army War College, Washington, D. C.
	July	Headquarters, Hq. & Serv. Company.	1-31	Fort Schuyler, N. Y.
		Company A	1-31	Bedford, N. Y.
		Company B	1-31	Raritan Arsenal, N. J.
		Company C	1-20	Army War College, Washington, D. C.
			20	Placed on inactive list.
	Aug. 1 to Sept. 30	Headquarters, Hq. & Serv. Company.		Fort Schuyler, N. Y.
		Company A		Bedford, N. Y.
		Company B		Raritan Arsenal, N. J.
		Company C		Inactive.
	October	Headquarters, Hq. & Serv. Company.	1-31	Fort Schuyler, N. Y.
		Company A	1-29	Bedford, N. Y.
			30-31	Fort Schuyler, N. Y.
		Company B	1-31	Raritan Arsenal, N. J.
1934	Nov. 1 to Apr. 30	Company C		Inactive.
		Battalion less Companies B and C.		Fort Schuyler, N. Y.
		Company B		Raritan Arsenal, N. J.
		Company C		Inactive.
	May	Battalion less Company C	1- 3	Army Base, Brooklyn, N. Y.
			5-24	En route to Port Angeles, via Panama Canal.
			25-31	Port Angeles, Wash.
		Company C		Inactive.
	June	Headquarters, Hq. & Serv. Company.	1-30	Port Angeles, Wash.
		Company A	1-13	Do.
			14-30	Clallam Bay, Wash.
		Company B	1- 4	Port Angeles, Wash.
			5-30	Forks, Wash.
		Company C		Inactive.
	July 1 to Sept. 30	Headquarters, Hq. & Serv. Company.		Port Angeles, Wash.
		Company A		Clallam Bay, Wash.
		Company B		Forks, Wash.
		Company C		Inactive.
	October	Headquarters, Hq. & Serv. Company.	1-31	Port Angeles, Wash.
		Company A	1-17	Clallam Bay, Wash.
			18-31	Fort Lawton, Wash.
		Company B	1-31	Forks, Wash.
		Company C		Inactive.
	November	Headquarters, Hq. & Serv. Company.	1-30	Port Angeles, Wash.
		Company A	1-30	Fort Lawton, Wash.
		Company B	1-30	Forks, Wash.
		Company C		Inactive.
	December	Headquarters, Hq. & Serv. Company.	1-31	Port Angeles, Wash.
		Company A	1- 6	Fort Lawton, Wash.
			6-31	Aberdeen, Wash.
		Company B	1- 8	Forks, Wash.
			9-31	Fort Lawton, Wash.
		Company C		Inactive.

Year	Month	Element	Dates	Station
1935	January	Headquarters, Hq. & Serv. Company.	1-31	Port Angeles, Wash.
		Company A	1-31	Aberdeen, Wash.
		Company B	1-31	Fort Lawton, Wash.
		Company C		Inactive.
	February	Headquarters, Hq. & Serv. Company.	1-28	Port Angeles, Wash.
		Company A	1-28	Aberdeen, Wash.
		Company B	1- 2	Fort Lawton, Wash.
			3-28	Forks, Wash.
		Company C		Inactive.
	March	Headquarters, Hq. & Serv. Company.	1-31	Port Angeles, Wash.
		Company A	1-31	Aberdeen, Wash.
		Company B	1-31	Forks, Wash.
		Company C		Inactive.
	April	Headquarters, Hq. & Serv. Company.	1-30	Port Angeles, Wash.
		Company A	1-29	Aberdeen, Wash.
			30	En route to Clallam Bay, Wash.
		Company B	1-30	Forks, Wash.
		Company C		Inactive.
	May 1 to July 31	Headquarters, Hq. & Serv. Company.		Port Angeles, Wash.
		Company A		Clallam Bay, Wash.
		Company B		Forks, Wash.
		Company C		Inactive.
	August	Headquarters, Hq. & Serv. Company.	1-31	Port Angeles, Wash.
		Company A	1- 6	Clallam Bay, Wash.
			7-31	Fort Stevens, Oreg.
		Company B	1-31	Forks, Wash.
		Company C		Inactive.
	September	Headquarters	1-30	Port Angeles, Wash.
		Hq. & Serv. Company	1-24	Do.
			25-30	Fort Lawton, Wash.
		Company A	1-30	Fort Stevens, Oreg.
		Company B	1-24	Forks, Wash.
			25-30	Fort Lawton, Wash.
		Company C		Inactive.
	October	Headquarters	1-31	Port Angeles, Wash.
		Hq. & Serv. Company	1-28	Fort Lawton, Wash.
			29-31	Port Angeles, Wash.
		Company A	1-31	Fort Stevens, Oreg.
		Company B	1-28	Fort Lawton, Wash.
			29-31	Forks, Wash.
		Company C		Inactive.
	November 1 to July 31	Headquarters, Hq. & Serv. Company.		Port Angeles, Wash.
		Company A		Fort Stevens, Oreg.
1936		Company B		Forks, Wash.
		Company C		Inactive.
	August	Headquarters	1-31	Port Angeles, Wash.
		Hq. & Serv. Company	1-26	Do.
			27-31	Fort Lawton, Wash.
		Company A	1-31	Fort Stevens, Oreg.
		Company B	1-26	Forks, Wash.
			27-31	Fort Lawton, Wash.
		Company C		Inactive.
	September	Headquarters	1-30	Port Angeles, Wash.
		Hq. & Serv. Company and Company B.	1-30	Fort Lawton, Wash.
		Company A	1-30	Fort Stevens, Oreg.
		Company C		Inactive.
	October	Headquarters, Hq. & Serv. Company.	1-31	Port Angeles, Wash.
		Company A	1-31	Fort Stevens, Oreg.
		Company B	1- 8	Fort Lawton, Wash.
			9-31	Fort Worden, Wash.
		Company C		Inactive.
	Nov. 1 to Dec. 31	Headquarters, Hq. & Serv. Company.		Port Angeles, Wash.
		Company A		Centralia, Wash.
		Company B		Fort Worden, Wash.
		Company C		Inactive.
1937	Jan. 1 to May 31	Headquarters, Hq. & Serv. Company.		Port Angeles, Wash.
		Company A		Centralia, Wash.
		Company B		Fort Worden, Wash.
		Company C		Inactive.

Year	Month	Element	Dates	Station
1937	June	Headquarters, Hq. & Serv. Company.	1- 3	Port Angeles, Wash.
			4	En route to Portland, Oreg.
			5-30	Portland, Oreg.
		Company A	1-30	Centralia, Wash.
		Company B	1-21	Fort Worden, Wash.
			22	En route to Portland, Oreg.
			23-30	Portland, Oreg.
		Company C		Inactive.
	July 1 to Aug. 31	Headquarters, Hq. & Serv. Company.		Portland, Oreg.
		Company A		Centralia, Wash.
		Company C		Inactive.
	September	Headquarters, Hq. & Serv. Company and Company B.	1- 3	Portland, Oreg.
			4-30	Camp Withycombe, Clackamas, Oreg.
		Company A	1- 3	Centralia, Wash.
			4-30	Camp Withycombe, Clackamas, Oreg.
		Company C		Inactive.
	October	Headquarters, Hq. & Serv. Company and Company B.	1- 6	Camp Withycombe, Clackamas, Oreg.
			7-31	Portland, Oreg.
		Company A	1- 6	Camp Withycombe, Clackamas, Oreg.
			7-31	Centralia, Wash.
		Company C		Inactive.
	Nov. 1 to Dec. 31	Headquarters, Hq. & Serv. Company and Company B.		Portland, Oreg.
		Company A		Centralia, Wash.
		Company C		Inactive.

ENGINEER TRAINING COMPANY NO. 1

Engineer Training Company No. 1 was organized October 1, 1921, at Camp Humphreys, Va., by transfers from the Thirteenth Engineers, under authority of Adjutant General's letter 320.2 Engr. Corps (Misc. Div.) dated August 25, 1921—C. E. file 320–P–80; and S. O. No. 89, Headquarters, Thirteenth Engineers, 1921.

Year	Month	Element	Dates	Station
1921	October	Engineer Training Company No. 1.	1–16	Camp Humphreys, Va.
			17–31	En route to Boston, Mass., by marching. At Franklin Park, N. J., Oct. 31.
	November	do	1–16	En route to Fort Revere, Mass.
			17–30	Fort Revere, Boston, Mass.
1922	Dec. 1 to Feb. 28	do		Do.
	March	do	1–21	Do.
			22	En route to Camp Devens, Mass.
			23–31	Camp Devens, Mass.
	Apr. 1 to Sept. 30	do.		Do.
	October	do.[54]	1– 9	Do.
			10–12	En route to Fort DuPont, Del.

---

[54] Company demobilized as of midnight Oct. 12, 1922, at Fort DuPont, Del., remaining personnel being transferred to 1st Engineers, under authority of letter A. G. 320.2 (7–15–22) (Miscl. Div.) M–3, dated July 18, 1922—C. E. file 320.2 (Engineers, Corps of) P–523.

ENGINEER TRAINING COMPANY NO. 2

Engineer Training Company No. 2 was organized October 1, 1921, at Camp Humphreys, Va., by transfers, from the Thirteenth Engineers under authority of Adjutant General's letter 320.2 Engr. Corps (Misc. Div.) dated August 25, 1921—C. E. file 320–P–80, and pursuant to S. O. No. 89, Headquarters, Thirteenth Engineers, 1921.

Year	Month	Element	Dates	Station
1921	October	Engineer Training Company No. 2.[55]	1–16	Camp Humphreys, Va.
			17–31	En route to Camp Dix, N. J.
1922	Nov. 1 to Apr. 30	do		Camp Dix, N. J.
	May	do.[56]	1–20	Do.

---

[55] Company en route by marching to Fort Slocum, N. Y. but was diverted to Camp Dix, N. J. per telegram A. G. O., dated Oct. 21, 1921, where it arrived on Oct. 31.

[56] All enlisted personnel transferred to First Engineers, per S. O. No. 137, Headquarters, Camp Dix., N. J., 1920. Company demoblized under authority of letter A. G. 320.2 (7–15–22) (Miscl. Div.) M–3, dated July 18, 1922, C. E. file 320.2 (Engineers, Corps of) P–523.

ENGINEER TRAINING COMPANY NO. 3

Engineer Training Company No. 3, was organized October 1, 1921, at Camp Humphreys, Va., by transfers from the Thirteenth Engineers under authority of Adjutant General's letter 320.2 Engr. Corps (Misc. Div.) dated August 25, 1921—C. E. file 320-P-80, and pursuant to S. O. No. 89, Headquarters, Thirteenth Engineers, 1921.

Year	Month	Element	Dates	Station
1921	October	Engineer Training Company No. 3.	1-16	Camp Humphreys, Va.
			17-19	En route to Camp Meade, Md.
			20-31	Camp Meade, Md.
	Nov. 1 to	do		Do.
1922	Aug. 31			
	September	do.[57]	1- 8	Do.
			9	En route to Camp Humphreys, Va.
			14-15	Camp Humphreys, Va.

---

[57] Enlisted personnel transferred to the Engineer School and Seventeenth Engineers. Company demobilized Sept. 15 under authority of letter A. G. 320.2 (7-15-22) (Misc. Div.) M-3, dated July 18, 1922, C. E. file 320.2 (Engineers, Corps of) P-523.

ENGINEER TRAINING COMPANY NO. 4

Engineer Training Company No. 4 was organized September 3, 1921, at Camp Jackson, S. C., by transfers from the Seventh Engineers under authority of Adjutant General's letter, 320.2 Engr. Corps (Misc. Div.) dated August 25, 1921—C. E. file 320-P-80.

Year	Month	Element	Dates	Station
1921	September	Engineer Training Company No. 4.	3-23	Camp Jackson, S. C.
			24-28	En route to Fort McPherson, Ga.
			29-30	Fort McPherson, Ga.
1922	Oct. 1 to Jan. 31	do		Do.
	February	do	1- 8	Do.
			9-10	En route to Camp McClellan, Ala.
			11-28	Camp McClellan, Ala.
	Mar. 1 to Aug. 31	do		Do.
	September	do.[58]	1- 9	Do.
			10-11	En route to Fort Du Pont, Del.
			12	Fort DuPont, Del.

---

[58] Company demobilized Sept. 12 under authority of letter A. G. 320.2 (7-15-22) (Misc. Div.) M-3, dated July 18, 1922—C. E. file 320.2 (Engineers, Corps of) P-523.

ENGINEER TRAINING COMPANY NO. 5

Engineer Training Company No. 5 was organized September 8, 1921, at Camp Grant, Ill., by transfers from the Twelfth Engineers under authority of Adjutant General's letter 320.2 Engr. Corps (Misc. Div.) dated August 25, 1921.

Year	Month	Element	Dates	Station
1921	September	Engineer Training Company No. 5.	8-26	Camp Grant, Ill.
			27-30	En route by marching to Camp Knox, Ky.
	October	do	1-25	Do.
			26-31	
1922	Nov. 1 to Aug. 31	do		Do.
	September	do [50]	1-16	Do.
			17-19	En route to Camp Travis, Tex.
			20	Camp Travis, Tex.

---

[50] Company demobilized Sept. 20 and personnel transferred to 2d Engineers under authority of letter A. G. 320.2 (7-15-22) (Misc. Div.) M-3 dated July 18, 1922—C. E. file 320.2 (Engineers, Corps of) P-523 and pursuant to G. O. No. 33, Headquarters 5th Corps Area, 1922.

ENGINEER TRAINING COMPANY NO. 6

Engineer Training Company No. 6 was organized September 8, 1921, at Camp Grant, Ill., by transfers from the Twelfth Engineers, under authority of Adjutant General's letter 320.2 Engr. Corps dated August 25, 1921.

Year	Month	Element	Dates	Station
1921	September	Engineer Training Company No. 6.	8-18	Camp Grant, Ill.
			19-23	En route to Fort Sheridan, Ill.
			24-30	Fort Sheridan, Ill.
	Oct. 1			
	to	do		Do.
1922	Mar. 31			
	April	do	1-20	Do.
			21	En route to Camp Custer, Mich.
			22-30	Camp Custer, Mich.
	May 1 to Aug. 31	do		Do.
	September	do	1-11	Do.
			12-13	En route to Fort Sheridan, Ill.
			14-30	Fort Sheridan, Ill.
	October	do [a]	1	Do.
			2-5	En route to Camp Travis, Tex.
			6-10	Camp Travis, Tex.

[a] Company demobilized Oct. 10 and personnel transferred to 2d Engineers under authority of letter A. G. 320.2 (7-15-22) (Misc. Div.) M-3, dated July 18, 1922, and pursuant to G. O. No. 49, Headquarters 2d Division, Camp Travis, Tex, 1922.

ENGINEER TRAINING COMPANY NO. 7

Engineer Training Company No. 7 was organized September 8, 1921, at Camp Grant, Ill., by transfers from the Twelfth Engineers, under authority of Adjutant General's letter 320.2 Engineer Corps (Misc. Div.), dated Aug. 25, 1921—C. E. file 320-P-80.

Year	Month	Element	Dates	Station
1921	September	Engineer Training Company No. 7.	8-21	Camp Grant, Ill.
			22-30	En route by marching to Fort Snelling, Minn.
	October	do	1-14	Do.
			15-31	Fort Snelling, Minn.
1922	Nov. 1 to Aug. 31	do		Do.
	September	do[61]	1-9	Do.

---

[61] Company demobilized Sept. 9 and enlisted personnel transferred to 6th Engineers, Camp Lewis, Wash., under authority of letter A. G. 320.2 (7-15-22) (Misc. Div.) M-3, dated July 18, 1922, and pursuant to G. O. No. 8, Headquarters Fort Snelling, Minn., 1922.

ENGINEER TRAINING COMPANY NO. 8

Engineer Training Company No. 8 was organized October 1, 1921, at Fort Sam Houston, Tex., by transfers from the Ninth Engineers under authority of Adjutant General's letter 320.2 Engineer Corps (Misc. Div.), dated August 25, 1921—C. E. file 320–P–80.

Year	Month	Element	Dates	Station
1921 1922	Oct 1 to Jan 31	Engineer Training Company No. 8.		Fort Sam Houston, Tex.
	February	do	1	Do.
			2–28	Camp Bullis, Tex.
	March	do	1–31	Do.
	April	do	1	Do.
			2–30	Fort Sam Houston, Tex.
	May 1 to July 31	do		Do.
	August	do	1–30	Do.
			31	Camp Travis, Tex.
	September	do [62]	1	Do.

---

[62] Company demobilized Sept. 1 and personnel transferred to 2d Engineers under authority of letter A. G. 320.2 (7–15–22) (Misc. Div.) M–3, dated July 18, 1922, and pursuant to G. O. No. 47, Headquarters 8th Corps Area 1922 and S. O. No. 204, Headquarters, 2d Division, 1922.

ENGINEER TRAINING COMPANY NO. 9

Engineer Training Company No. 9 was organized September 21, 1921, at Camp Lewis, Wash., by transfers of 3 officers and 45 enlisted men from the Fourth Engineers, under authority of Adjutant General's letter 320.2 Engineer Corps (Misc. Div.) dated August 25, 1921—C. E. file 320–P–80, and pursuant to G. O. No. 20, Headquarters, Ninth Corps Area, 1921.

Year	Month	Element	Dates	Station
1921	September	Engineer Training Company No. 9.	21–23	Camp Lewis, Wash.
			24–27	En route to Presidio of San Francisco, Calif.
			28–30	Presidio of San Francisco, Calif.
1922	Oct. 1 to May 31	do		Do.
	June	do	1–4	Do.
			5–30	Fort Barry, Calif.
	July	do	1–31	Presidio of San Francisco, Calif.
	August	do	1–4	Do.
			5–13	En route by marching to Del Monte, Calif.
			14–31	Camp Del Monte, Calif.
	September	do[63]	1	En route to Presidio of San Francisco, Calif.
			2–6	Presidio of San Francisco, Calif.

---

[63] Company demobilized Sept. 6 and personnel transferred to Company E, 6th Engineers at Fort Winfield Scott, Calif., under authority of letter, A. G. 320.2 (7–15–22) (Misc. Div.) M–3, dated July 18, 1922—C. E. file 320.2 (Engineers, Corps of) P–523, and pursuant to Special Order No. 195, Headquarters, 9th Corps Area, 1922.

INDEX

	Page
Company A, Sappers, Miners, and Pontoniers (1846–1861)	1
U. S. Engineer Battalion (1861–1901)	3
Company A, Topographical Engineers (1861–1863)	9
First Battalion of Engineers (1901–1916)	10
Second Battalion of Engineers (1901–1916)	17
Third Battalion of Engineers (1901–1916)	25
The Engineer Band (1901–1916)	32
First Engineers (1916–1937)	33
First Engineer Train (1917–1921)	45
Second Engineers (1916–1937)	46
Second Engineer Train (1917–1921)	53
Third Engineers (1916–1937)	54
Fourth Engineers (1917–1937)	62
Fourth Engineer Train (1917–1920)	64
Fifth Engineers (1917–1937)	65
Fifth Engineer Train (1917–1921)	68
Sixth Engineers (1917–1937)	69
Sixth Engineer Train (1917–1920)	77
Seventh Engineers (1917–1937)	78
Seventh Engineer Train (1917–1921)	80
Eighth Engineers (Squadron) (1916–1937)	81
Eighth Engineer Train (Mounted) (1917–1921)	85
Ninth Engineers (Squadron) (1917–1937)	86
Ninth Engineer Train (Mounted) (1917–1921)	89
Eleventh Engineers (Railway) (1917–1919)	91
Eleventh Engineers (Combat) (1920–1937)	92
Twelfth Engineers (Squadron) (1917–1937)	99
Twelfth Engineer Train (318th Engineer Train) (1918–1920)	100
Thirteenth Engineers (Railway) (1917–1919)	101
Thirteenth Engineers (Combat) (1921–1937)	103
Fourteenth Engineers (1921–1937)	107
Sixteenth Engineers (Railway Battalion) (1921–1924)	114
Seventeenth Engineer Battalion (Topographical) (1921–1923)	115
Eighteenth Engineers (Light Bridge Train) (1921–1922)	116
Twenty-ninth Engineers (Topographic) (1917–1919)	117
Twenty-ninth Engineer Battalion (Topographic) (1923–1937)	122
Engineer Training Company No. 1 (1921–1922)	127
Engineer Training Company No. 2 (1921–1922)	128
Engineer Training Company No. 3 (1921–1922)	129
Engineer Training Company No. 4 (1921–1922)	130
Engineer Training Company No. 5 (1921–1922)	131
Engineer Training Company No. 6 (1921–1922)	132
Engineer Training Company No. 7 (1921–1922)	133
Engineer Training Company No. 8 (1921–1922)	134
Engineer Training Company No. 9 (1921–1922)	135

The two captains taught mathematics; the one in the line of geometrical, the other in that of algebraical demonstration.

From its very organization some commissioned officers of the corps were engaged upon the fortifications of the coast, and the majority of those who acted the part of teachers, during the first 2 or 3 years of the existence of the academy, were soon replaced by teachers and professors appointed to instruct in special subjects. By February of 1808 but one officer of the corps remained at the Military Academy, serving in the capacity of acting superintendent, and also as instructor of certain branches. In the words of Colonel Williams—

> It was not probably foreseen, that although the headquarters of the corps might be at West Point, yet the duties of the individual officers necessarily spread them along our coast from one extremity of the United States to the other, and, as the whole number of officers can be no more than sixteen, they could not in their dispersed state constitute a Military Academy. The incongruity of a stationary and errant existence of the same corps has been amply exemplified by experience.

It is not proposed to write here a history of the Military Academy or to quote the laws concerning it, although its early history was closely related to that of the Corps of Engineers. It is sufficient to say that the charge and superintendency of the academy remained with the Corps of Engineers until July 13, 1866, when by act of Congress it passed to the Army at large. As to this stewardship Ingersoll, in his History of the War Department, says—

> It is proper here to observe that, from this time until the year after the close of the War of the Rebellion, the Military Academy remained under the charge of the Corps of Engineers. During this period the academy grew from a school of humble pretensions to an institution of the most complete character, furnishing to its cadets as thorough a military education, practically and scientifically, as could be gained at almost any other similar institution in the world. The present efficiency of the academy, everywhere acknowledged, was given to it during the sixty years' control by the Corps of Engineers.

To this commendation of the work of the corps at the academy during the formative period and its first sixty years of usefulness there need only be added that the records of its graduates are the best evidences of the success of the school and from its students of that period West Point not only furnished to the Army military leaders of the highest training and ability but also supplied to the commercial and transportation interests of the country technically trained men at a time when such training was to be had at almost no other school on this continent.

The first enlisted men of the present corps were authorized by the act of February 28, 1803, which provided:

> SEC. 3. That the commanding officer of the Corps of Engineers be authorized to enlist, for a term not less than three years, one artificer and eighteen men, to aid in making practical experiments, and for other purposes, etc., etc.

In the latter part of 1802 there arose the question of the right of engineer officers to command outside of their own branch of the service and upon reference of the matter to the War Department the decision was adverse to the corps. An appeal was made to the President but without result and the two field officers of the corps resigned, Lieutenant Colonel Williams in June 1803 and Major Wadsworth in February 1805.

The controversy was definitely settled by the issuance of General Orders of April 17, 1805, confirming the previous decision and fixing the status of engineer officers as not belonging to the line. By this order, they were to assume command in the line only by special order of the President and the order was given the force of law by the enactment of the Sixty-third Article of War on April 10, 1806. Upon the acceptance by him of the President's conclusions, Colonel Williams was reappointed lieutenant colonel and Chief Engineer, April 19, 1805. A more complete account of this controversy will be found later.

On the 23d of February 1808 the corps was filled by regular promotions to the full numbers authorized by the organic act of March 6, 1802. Jonathan Williams was the colonel and Chief Engineer, Jared Mansfield the lieutenant colonel, and Alexander Macomb and Joseph G. Swift the majors. With the exceptions of Lieutenant Colonel Mansfield, who had been surveyor general of the Northwest Territory since November 1, 1803, with office at Cincinnati, and of Lt. Alden Partridge, who was retained at the Military Academy, all the officers of the corps were spread along the coasts in charge of active operations upon fortifications. The Office of the Chief Engineer was in New York Harbor.

The act of April 29, 1812, increased the number of commissioned officers from 16 to 22 by an increase of 2 each in the grades of captain, first and second lieutenant, and provided the first company of engineer troops in the following provisions:

> SEC. 1. That there be added to the Corps of Engineers two captains; two first lieutenants; two second lieutenants; with the usual pay and emoluments according to their grades respectively; and one paymaster, to be taken from the subalterns of engineers, with the pay and emoluments of a regimental paymaster, and that there be attached to the said corps, either from the troops now in service or by new enlistments, as the President of the United States may direct, four sergeants, four corporals, one teacher of music, four musicians, nineteen artificers, and sixty-two men, which noncommissioned officers, musicians, artificers, and men, together with the artificers and men already belonging to the Corps of Engineers, shall be formed into a company, to be styled a company of bombardiers, sappers, and miners, and be officered from the Corps of Engineers, according as the commanding officer of that corps may, with the approbation of the President of the United States, direct.
>
> SEC. 6. That so much of the twenty-sixth section of the act entitled "An act fixing the military peace establishment," passed the 16th day of March 1802, as confines the selection of the command of the Corps of Engineers to the said corps be, and the same is hereby, repealed.

By section 4 of the same act it was provided—

> That when any cadet[1] shall receive a regular degree from the academical staff, after going through all the classes, he shall be considered as among the candidates for a commission in any corps, according to the duties he may be judged competent to perform; and in case there shall not, at the time, be a vacancy in such corps, he may be attached to it at the discretion of the President of the United States, by brevet of the lowest grade, as a supernumerary officer, with the usual pay and emoluments of such grade until a vacancy shall happen: *Provided*, That there shall not be more than one supernumemary officer to any one company at the same time.

Under the authority of this statute supernumerary officers have been attached at different times to the corps in varying numbers as

as to call forth the most eulogistic commendations from the commanding general. Other officers were deterred from doing likewise only by circumstances which did not permit of their so doing.

---

[1] Of the U. S. Military Academy.

On the 3d of April 1818 the headquarters of the Engineer Department were transferred from New York to Washington under the following order:

> DEPARTMENT OF WAR,
> *April 3, 1818.*
>
> SIR: The President having directed that the headquarters of the Engineer Department be fixed at the seat of government, you will make your arrangements accordingly. As soon as practicable, you will order the distribution of the officers of the Engineer Corps, in such manner as the service of surveying sites, and the superintendence of the construction of works of defence may require.
>
> Until you can be otherwise accommodated, you will procure suitable rooms for offices.
>
> J. C. CALHOUN.
>
> Gen. J. G. SWIFT.

On the 7th of April 1818 regulations for the government of the Engineer Department were issued by the Secretary of War, Mr. Calhoun, with the approval of the President. About this time the Engineer Department included the Corps of Engineers, the Topographical Engineers, and the Military Academy. The Topographical Engineers were "arranged to the Engineer Department, and made subject to the orders of the Chief Engineer and commanding engineers," by formal orders dated July 2, 1818, but a number of the Topographical Engineers had for nearly 2 years been doing duty under the Chief Engineer, with the Board of Engineers, and on other stations.

On the 12th of November 1818 Bvt. Brig. Gen. J. G. Swift, Chief Engineer, resigned his commission in the Army, and on the 22d of the same month Lt. Col. W. K. Armistead, Corps of Engineers, assumed the command of the corps. On the 10th of March 1819, Lieutenant Colonel Armistead was appointed colonel, Corps of Engineers, and Chief Engineer, to rank from November 12, 1818.

By the act of March 2, 1821, to reduce and fix the peace military establishment, it was enacted:

> SEC. 1. That from and after the first day of June next, the military peace establishment of the United States shall be composed of four regiments of artillery, and seven regiments of infantry, with such officers of engineers, of ordnance, and of the staff, as are hereinafter provided for.
>
> * * * * * * *
>
> SEC. 3. That the Corps of Engineers (bombardiers excepted) and the Topographical Engineers and their assistants shall be retained in service as at present organized.

Under the operations of this act, Colonel Armistead resigned his office of Chief Engineer, and accepted the appointment of colonel of the Third Regiment of Artillery, while Brig. and Bvt. Maj. Gen. Alexander Macomb returned to service with the Corps of Engineers, as colonel and Chief Engineer. The enlisted men of the Company of Bombardiers, Sappers, and Miners were either discharged or transferred to the company of artillery which was stationed at West Point in its stead.

In releasing command of the corps in 1828 after his promotion to be major general and upon his assignment to the command of the

Army, General Macomb published the following orders, dated May 28:

> Major General Macomb, in leaving the office of Chief Engineer, which he has filled for the last 7 years, to take command of the Army, feels it but an act of justice to the officers attached to the Engineer Department to express the great satisfaction he has experienced from their zealous and efficient cooperation in every branch of the service connected with his duties.
>
> To the officers of the Corps of Engineers he makes his fullest acknowledgments for the judicious and faithful manner in which they have directed the construction of the fortifications, and other works confided to their superintendence, and for the unceasing efforts to sustain, in whatever situation they have been placed, the honor and reputation of the corps.
>
> To the officers of the Topographical Engineers, and those detailed from the line of the Army to assist in the surveys and reconnaissances relating to internal improvements, and to the gentlemen who have acted as civil engineers, Major General Macomb in like manner tenders his acknowledgments.
>
> To the commissioners and superintendents of laying out and constructing roads, the Chief Engineer has every reason for making a public acknowledgment of their faithful and valuable services.
>
> To the superintendent and officers composing the staff of the Military Academy, he takes great pleasure in expressing his sense of their enlightened and successful exertions to elevate and maintain the character of that valuable institution.
>
> And to the members of the board of engineers for fortifications and internal improvements, too much praise cannot be given for the industry and intelligence with which they have discharged the important and arduous duties committed to them.
>
> In closing this order, the Chief Engineer cannot refrain from stating with proud satisfaction the fact that during the period for which he has presided over the department, no loss has been occasioned to the public by any defalcation or neglect on the part of its officers, especially when it is considered that the amount of 6 millions of dollars has been disbursed in small sums and for items of a nature that require the greatest care and attention to satisfy the strictness of the accounting officers, and to comply with the established regulations of the department.
>
> The major general will never cease to take a great interest in the success and prosperity of the Engineer Department, and will, so far as it may be in his power, lend his aid to promote its usefulness, and, if possible, to increase its consideration in the public estimation.
>
> ALEXANDER MACOMB,
> *Maj. Gen., Chief Engr. of the U. S.*

General Macomb was succeeded as colonel and Chief Engineer by Lieut. Col. Charles Gratiot, of the Corps of Engineers.

On the 22d of June 1831, by a regulation of the War Department, the Topographical Bureau of the Engineer Department was constituted a distinct Bureau of the War Department, and the officer in charge thereof was directed to communicate directly with the Secretary of War, from whom he was to receive all his orders, and to whom he was to make all his reports.

On the 10th day of August 1831, Bvt. Brig. Gen. Simon Bernard resigned his office, and returned to France, Col. James Gadsden being appointed "Assistant Engineer" by the President in his place. This office was discontinued October 1, 1832, by virtue of the joint resolution of Congress of July 14, 1832.

By the act of July 5, 1838, to increase the military establishment of the United States, the commissioned strength of the corps was increased to 43 and mounted pay was authorized in these sections:

> SEC. 2. That the President of the United States be, and he is hereby, authorized to add to the Corps of Engineers, whenever he may deem it expedient to increase the same, one lieutenant colonel, two majors, six captains, six first and

six second lieutenants, and that the pay and emoluments of the said corps shall be the same as those allowed to the officers of the regiment of dragoons.

SEC. 3. That so much of the act passed the 29th day of April 1812, entitled "An act making further provision for the Corps of Engineers," as provides that one paymaster shall be taken from the subalterns of the Corps of Engineers, be, and the same is hereby, repealed, and that the paymaster so authorized and provided be attached to the Pay Department, and be in every respect placed on the footing of other paymasters of the Army.

SEC. 27. That it shall be the duty of the engineer superintending the construction of a fortification, or engaged about the execution of any other public work, to disburse the moneys applicable to the same, and as a compensation therefor may be allowed by the Secretary of War at the rate of two dollars per diem during the continuance of such disbursements: *Provided*, That the whole amount of emolument shall not exceed 1 percent on the sum disbursed.

But by the act of July 7, 1838, it was provided:

That no compensation shall be allowed to officers of the Engineer Department for disbursement of public money while superintending public works.

On the 6th day of December 1838, Col. and Bvt. Brig. Gen. Charles Gratiot was dismissed from the service by an order of the President. This dismissal of General Gratiot arose from his refusal to settle his accounts in accordance with the decisions of the Comptroller of the Treasury, which General Gratiot believed were not in accordance with law. He was succeeded in the office of Chief Engineer by Lt. Col. Joseph G. Totten, who held the office until his death on April 22, 1864.

In accordance with the instructions of the Secretary of War on August 1, 1838, there were transferred, by the 18th of June 1839 to the Corps of Topographical Engineers, organized the preceding year, some 70 or more works of improvement of harbors and rivers along the Gulf, Atlantic, and Lake coasts.

The chief of the corps had for years urged upon Congress, in vain, the necessity for having at least one company of engineer soldiers as a part of our peace establishment, but the active opposition to a permanent military establishment and the strong prejudice against maintaining in time of peace even a small regular army, rendered his efforts of no avail and from the disbanding in 1821 of the Company of Bombardiers, Sappers and Miners organized for the war of 1812 there had been no engineer troops in our service.

THE ENGINEERS IN THE WAR WITH MEXICO

In 1846, after the battle of Palo Alto and the beginning of the war with Mexico, a company of sappers, miners, and pontoniers was added to the corps by the act of May 15, which provided—

That there be added to the Corps of Engineers one company of sappers, miners, and pontoniers, to be called engineer soldiers; which company shall be composed of ten sergeants, or master workmen, ten corporals, or overseers, two musicians, thirty-nine privates of the first class, or artificers, and thirty-nine privates of the second class, or laborers; in all, one hundred men.

SEC. 2. That the pay and rations of the sergeants, or master workmen, of said company shall be the same as those now allowed by law to the master workmen employed by the ordnance department, excepting that the engineer sergeants shall receive one ration only per day instead of one ration and a half; of the corporals, or overseers, the same as those now allowed by law to the armorers, carriage makers, and blacksmiths employed by the ordnance department, excepting that the engineer corporals shall receive one ration only per day, instead of one ration and a half; of the privates of the first class, or artificers, the same as those now allowed by law to the artificers employed by the ordnance department; of the privates of the second class, or laborers, the same as those now allowed by law to the laborers employed by the ordnance department, and of the musicians the same as those allowed by law to the musicians of the line of the Army; the said noncommissioned officers, privates, and musicians being, respectively, entitled to the same clothing and other allowances as are granted by law to noncommissioned officers, privates, and musicians of the artillery of the Army of the United States.

SEC. 3. That the said engineer company shall be subject to the rules and articles of war, shall be recruited in the same manner and with the same limitation, and shall be entitled to the same provisions, allowances, and benefits in every respect, as are allowed to the troops constituting the present military peace establishment.

SEC. 4. That the said engineer company shall be attached to and compose a part of the Corps of Engineers, and be officered by officers of that corps, as at present organized; they shall be instructed in and perform all the duties of sappers, miners, and pontoniers, and shall aid in giving practical instructions in these branches at the Military Academy; they shall, moreover, under the orders of the Chief Engineer, be liable to serve by detachments, in overseeing and aiding laborers upon fortifications or other works under the Engineer Department, and in supervising finished fortifications as fortkeepers, preventing injury and applying repairs.

SEC. 5. That the Chief Engineer, with the approbation of the Secretary of War, be authorized to regulate and determine the number, quality, form, dimensions, etc., of the necessary vehicles, pontons, tools, implements, arms, and other supplies for the use and service of said company as a body of sappers, miners, and pontoniers.

The company so authorized was designated Company A, Corps of Engineers. Subsequently it became part of the Battalion of Engineers and, upon the reorganization in 1901, was assigned to the First Battalion of Engineers, retaining its original company letter. To it was assigned in 1846 as its first commander, Capt. Alexander J. Swift, who had shortly before returned from a tour of instruction in the French school for engineer officers at Metz. His lieutenants were Gustavus W. Smith and George B. McClellan. Lt. John G. Foster joined the company later at Tampico.

By the last of September the company had been recruited, organized, and drilled, and was ordered to join General Taylor's army, arriving at Brazos Santiago on October 11, 1846. From Brazos the company proceeded to the mouth of the Rio Grande and subsequently started upon its return to Brazos, en route to Tampico by sea, but was diverted to Matamoros and thence proceeded by marching to Tampico, where it took transport to Vera Cruz. Landing on the beach with the first line, it rendered arduous and valuable services during the siege of Vera Cruz. Captain Swift with 20 men of the company had been left sick in the hospital at Matamoros. Although still very sick, he rejoined his command at Tampico and landed with it at Vera Cruz, so weak that it was necessary to carry him ashore. Within 24 hours he succumbed entirely, and being taken on shipboard was sent by the first steamer to New Orleans, where he died a few hours after his arrival.

During the remainder of the war the company served with General Scott's command, taking part in the battles of Cerro Gordo, Contreras, Churubusco, Chapultepec, and Garita San Cosme. In many of these actions the company, in addition to performing the duties of sappers and miners, formed a part of the attacking force. At Molino del Rey, Lieutenant Foster with a detachment of 10 men from the company participated in the assault and was himself wounded. Captain Swift's early death from exposure in the field has been mentioned. The other 3 officers lived to gain the commissions of major generals during the Civil War and one of them to command the Army of the Potomac.

Nineteen officers of the Corps of Engineers served with the armies in Mexico, including the Chief Engineer, Colonel Totten, in whose professional skill General Scott had such unbounded confidence that he called him from Washington to take charge of the engineer operations of his army. None of these engineers had command of troops outside of their own branch of the service. All but the four attached to the engineer company were on staff duty and the company officers were also utilized for the same work to a considerable extent. In General Scott's army the engineers found their greatest opportunities, both from the circumstances of the campaign and from the character of the commanding general. In the war of 1812 General Scott was intimately associated in his earliest campaigns with such brilliant and earnest men as McRee, Wood, Totten, and others and valued highly the services rendered by them. In the Mexican war he followed the example set him by General Brown in 1814 and, utilizing his engineers to the fullest extent, found among them such men as Lee, Beauregard, McClellan, Isaac I. Stevens, and others whose names became household words in the great struggle to follow a few years later. That these engineers accepted their opportunities with gallantry and efficiency is evident from the record of casualties and brevets that follows below, but the full record of their services will always remain a part of the unwritten history of this war.

With General Scott were 12 engineer officers. Colonel Totten directed the siege operations in front of Vera Cruz, with the able assistance of his subordinates, and won high commendations for himself and his officers upon the conduct of the siege. He served as a member of the commission that arranged the terms of capitulation and, after the fall of the city, returned to Washington as the bearer of General Scott's despatches announcing the success of the army, receiving subsequently the brevet of brigadier general for gallant and meritorious conduct.

Captain Swift was invalided and died a few weeks later. Of the 10 engineers who served with Scott's army in the short and brilliant campaign from Vera Cruz to the City of Mexico, 1 was invalided toward the end of the movement and 7 were wounded. One of the 10 received a single brevet, 6 were twice brevetted, and 3 (Lee, Tower, and McClellan) were brevetted 3 times—all for gallant and meritorious conduct. Three of the 10 died before 1860 and 6, including, in the order of their rank in 1847, R. E. Lee, P. G. T. Beauregard, Isaac I. Stevens, Gustavus W. Smith, George B. McClellan, and John G. Foster held command as major generals or higher on one side or the other during the rebellion. Three of them commanded the opposing armies in Virginia and one (McClellan) received the thanks of Congress. The eleventh, Tower, became a brigadier general of volunteers in 1861, but was so badly wounded at Manassas in 1862 as to be incapacitated for service for 2 years, receiving five brevets, including brevets of major general in both the army and the volunteers, for gallant and meritorious conduct. The records made by this little group of officers as a whole are unequaled in our service.

Of them, General Worth, in reporting upon the operations resulting in the capture of the city of Mexico, says—

> Of the staff, Lieutenants Stevens, Smith, and McClellan, engineers, displayed the gallantry, skill, and conduct which so eminently distinguished their corps.

And General Scott upon the same operations says [5]—

> The victory of the 8th at the Molino del Rey was followed by daring reconnaissances on the part of our distinguished Engineers—Captain Lee, Lieutenants Beauregard, Stevens, and Tower. * * *
>
> * * * Captain Lee, so constantly distinguished, also bore important orders from me (September 13) until he fainted from a wound and the loss of two nights' sleep at the batteries. Lieutenants Beauregard, Stevens, and Tower, all wounded, were employed with the divisions and Lieutenants G. W. Smith and G. B. McClellan with the company of sappers and miners. Those five lieutenants of engineers, like their captain, won the admiration of all about them.

Many similar encomiums upon the gallantry and professional skill of the engineers individually and as a body will be found among the official reports of this campaign, particularly in those of General Scott, in whose esteem and confidence they held an exalted place. From among them all General Scott selected to receive his highest praise, Captain Lee, of whom in a letter to the Secretary of War dated May 8, 1857, he says in asking for a commission for Colonel Lee's son—

> I make this application mainly upon the extraordinary merits of the father—the very best soldier that I ever saw in the field. * * *

Lee held to General Scott in 1847 the same confidential relation that McRee held with General Brown in 1814, and the events of 1861–65 proved the correctness of Scott's judgment of soldiers and of Lee in particular.

The engineers who served in other fields of operation during the Mexican War were relatively less distinguished as a whole only by reason of less brilliant opportunities. Of the seven who so served two were wounded and all who were in action were brevetted for gallant and meritorious conduct. Among them were J. K. F. Mansfield, wounded and twice brevetted while Chief Engineer of General Taylor's army, who was afterwards killed at the battle of Antietam in 1862 in command of the Twelfth Army Corps; J. G. Barnard, who constructed the defenses of Tampico; W. D. Fraser, aide to General Wool, who was brevetted at Monterey, and died in 1856; H. W. Benham, who was wounded and brevetted at Monterey and became a brigadier general of volunteers in 1861; J. M. Scarritt, brevetted at Monterey, died in 1854; H. W. Halleck, brevetted for gallant conduct, major general, General in Chief, and Chief of Staff during the Civil War; and J. F. Gilmer, not in action, major general in the Confederate army.

Regarding the services during the Mexican War of the graduates of the Military Academy as a whole, the Hon. Randolph B. Marcy, Secretary of War during the administration of President Polk, expressed himself as follows in December 1848—

> Among the considerations which render the United States Military Academy at West Point an appropriate depository of the trophies of the successful

---

[5] General Scott's Report, written in the National Palace of Mexico, September 18, 1847.

NUMBER 64
OCCASIONAL PAPERS
THE ENGINEER SCHOOL
UNITED STATES ARMY

CONSTRUCTION IN WAR

LESSONS TAUGHT BY THE WORLD WAR
1917–1919

(WITH FOLIO OF PLATES)

PREPARED UNDER THE DIRECTION OF
THE CHIEF OF ENGINEERS

By
ERNEST GRAVES
Major, Corps of Engineers, U. S. Army

FOR USE AT THE ENGINEER SCHOOL
UNITED STATES ARMY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1921

out that each usable unit is completed in succession in such a way that it can be used immediately. Thus the construction will lend itself continuously to the military necessity, and a change in the military situation which stops all the construction will not leave such a large quantity unused and useless. It sometimes happens that work carried on in this way is not so economical of labor and material as if parts requiring similar construction methods are built at the same time. However, the satisfying of the immediate military requirements is the first consideration and should rule. For instance, it is wrong to start a number of storehouses when one house is needed, and all labor and material could be devoted to providing this necessity immediately. Similarly, it is wrong to lay 10 railroad tracks in a yard before aligning and ballasting any, when perhaps only three tracks are needed immediately, and the available labor could be devoted to laying, aligning, and ballasting these first. When electric power is needed it is generally better to use a small gasoline unit to fulfill immediate needs and to add units when demands increase rather than start a large power house which may never operate at all. The loss of efficiency due to small units amounts to little compared to fulfilling the requirements of the military situation. Intelligent supervision and planning will keep construction ahead of military necessities, while blind and unintelligent following of plans will not provide necessities in time.

Administration and organization.

4. In the administration of construction work over an extended territory two things are quite essential: First, there should be an engineer in each locality in charge of all engineering work, including buildings, railroads, electricity, water supply, and every other kind of engineering work, and, second, responsibility and authority should be decentralized as much as possible. The only way in which limited materials and labor can be properly applied is for one head to decide which feature of construction is most in demand, and to apply all available means to the job most necessary. This is in accordance with the principle stated above that a usable unit must be rushed to completion before parts of other units are started. The head which supervises all engineering work in a theater of operations must have similar heads in various localities. The work should not divide into specialties until it gets small enough to be supervised in detail by one man. This is true of control, but does not mean that higher supervising heads should not have advisers in specialties. However, these advisers should not be permitted to interfere with the supervision of local heads over the various specialties.

5. Higher supervisors should delegate as much authority and responsibility to subordinates as is possible, because, in war, communication is slow and local necessities are best known by the local man.

6. Plans should be considered only as guides to keep the local men informed of general policies, and should be changed at will to meet local conditions and to conform to available materials and labor.

Simplicity.

7. The maxim of Napoleon of *simplicity in war* is as much applicable to construction as to any other feature of war. All designs should be of the simplest kind, requiring only the most common construction materials and supplies. For instance, water supplies should be of a few standard sizes of pipe and fittings with simple pumps. Electric installations should be made with simple machines that do not require extraordinary personnel to install and repair, etc.

PERSONNEL.

8. The only construction necessities are cover, water, and latrines.

Cover in general.

9. Men require protection from the weather according to climate, season of the year, etc. The nature of this protection is dependent upon the probable time of occupancy. Soldiers on the march rest and sleep in the shelter tents which they carry on their backs. If they are to stop in one locality for several weeks, it is desirable that large tents be provided. If occupancy seems fairly certain for an extended period, barracks may be advisable and economical from the standpoint of transportation, materials, and health. In the World War the use of barracks rather than large tents in many cases was a mistake. Stationary and trench warfare created a false impression as to the advisability of barracks which was not fully realized. It was useless for the First American Army to attempt a large barrack program in the front-line area, because movements were too rapid for barrack erection. Transportation facilities were acute and were growing more so every day. Large tentage could have moved with a small percentage of the freight cars which were required for barracks. It is believed that large tentage should be kept on hand for about 40 per cent of any military force so as to avoid unnecessary barrack construction, and that barracks should be used only when occupancy for long periods is assured, since the wearing out of tents makes the providing of lumber advisable only when long use is contemplated.

Layout and location.

10. In locating a camp of any kind, either of tents or barracks, care should be exercised to take advantage of all local facilities to avoid unnecessary construction. If tents are likely to be changed to barracks, space allowances should be sufficient to permit of the change. Any existing roads should be taken advantage of in order to avoid road construction, which is most expensive in labor, materials, and transportation. Kitchens should be placed adjacent to the road.

Types shown in Field Service Regulations should be followed in pri ciple. Plans on plate 1 of accompanying folio show how barrack 20 by 100 feet can be best located to use an existing road, either whe available road space is long and narrow, more or less square, or nar row and deep. The plans also show proper spacing to make i improbable that fire could spread from one barracks to another although, of course, this is not assured. Barracks with this spacing were seen to burn in France, and men were able to keep the fire from spreading by wetting the adjacent barrack with buckets of water. The plan on plate 2 of folio shows how camps were laid out on existing roads near Le Mans, France. In this case special large kitchens were used.

Space allowances.

11. Military necessity usually surmounts sanitary desires in the matter of space allowances. Medical authorities say that a man should have about 600 cubic feet of space. Sometimes they prescribe even more. Generally they say certainly not less than 400 cubic feet. In discussing barrack space, this is usually spoken of in square feet, the barrack being assumed to have an average height of 10 feet, which may or may not be so. The decision in this matter is taken by the military authorities, since the medical authority can not carry the responsibility incident to the necessary reduction in his recommendation for air space. In the World War the foreign armies allowed about 40 square feet of barrack space per man, but the American Army operated and increased its personnel so fast that by necessity its allowances were about 50 per cent of this. Men were placed in double-tiered four and eight-men bunks, and received an allowance of not over 20 square feet per man. A four-man bunk is shown on plate 3 of folio. The following quotation from orders of general headquarters, A. E. F., shows what military necessity brought about in the World War:

> 3. The following allowances of floor space will govern officers charged with constructing shelter for our troops:
>
> (*a*) *Enlisted men.*—Bunks 2 feet 8 inches wide by 6 feet 6 inches, double tier, in sets of four, 2 feet 8 inches apart, giving 1 linear foot of Adrian barracks (20 square feet) per man. For company (250 men) kitchen and storeroom, 12 linear feet of Adrian barracks (240 square feet), and 1 additional linear foot (20 square feet) for each three men of the organization as dining room.
>
> (*b*) *Nurses.*—One room 10 by 14 feet for each two nurses. Kitchen allowance same as for enlisted men. Dining room allowance, 2 linear feet of barracks (40 square feet) for each three nurses.
>
> Where nurses are now accommodated in Adrian or other similar type barracks their quarters will be altered to conform to the above. (As amended by sec. 1, par. 1, G. O. 58, 1918.)
>
> (*c*) *Officers.*—One room 10 by 14 feet for each colonel; one similar room for each lieutenant colonel or major. For officers below the grade of major rooms will be provided for use in common on a basis of not less than 70 square feet of floor space for each officer. When officers are quartered in an Adrian or similar barracks, 14 square

feet of space allowed for each officer will be taken for a common assembly room, which will be separated from the balance of the building by a full-height partition. For kitchen and storeroom for officers 10 linear feet of barracks (200 square feet) will be allowed, and for dining room 2 linear feet of barracks for each three officers (13⅓ square feet per officer).

(*d*) *Hospitals.*—One bed for each 3 linear feet[1] (60 square feet) of Adrian barracks. Kitchen allowance, 18 linear feet (360 square feet) of Adrian barracks for 300 men, and 24 linear feet (480 square feet) for 500 men. Dining room allowance, 2 linear feet (40 square feet) of Adrian barracks for each three men of hospital capacity.

4. Lower bunk frames should clear the floor by 18 inches and there should be room enough between the upper and lower bunks to allow a person to sit upright in the lower bunk. Company barracks, kitchen, and dining rooms will not be floored.

5. The stove allowance is amended to give one stove for each 33 linear feet (660 square feet) of Adrian barracks, or one stove to each room.

Type of barracks.

12. In determining upon the type of house to use it is best to consider local practice. In France designs were used which could be made from the short lengths of lumber used in that country. Demountable buildings were used to a large extent, because they could be made up in shops with machinery and economy in labor and in lumber. In the punitive expedition into Mexico huts were made of "dobe" brick, which could be made on the site and sundried. Where the barrack has to be transported any distance, it is certain that wood, or wood and corrugated iron are best, because more cover can be gotten for the same amount of transportation than with any other materials.

13. Some types of barracks 20 by 100 feet that have been used are shown on plates 4 to 23 of folio. Plates 4 and 5 show an American design that is easy to build with lumber. Plate 6 shows about the same design with corrugated iron substituted for lumber on roof and sides. The lining of roofing paper indicated on the drawing can be omitted. On plates 7 to 13 are shown two French demountable barracks. The Adrian type was most common in France. The barrack shown on plates 14 to 16 was a knocked-down barrack rather than a demountable barrack, and more of these barracks could be shipped on a car than of any other kind. The hut shown on plates 17 to 19 was convenient when a small building was desired. The Nissen hut shown on plates 20 to 23 was an English design to permit the use of metal instead of lumber, which was very scarce in England. In general, except where special conditions obtain, barracks for personnel about 20 by 100 feet are best on account of simplicity of construction. Where space is limited a two-story barrack may be advisable, but this is exceptional. A larger barrack may be more economical in the material used per man, but complications in roof trusses and the inadvisability of putting too many men in one building make the smaller building best in general.

---

[1] Instructions to provide equipment for 1,200 patients in a 1,000-bed unit modify this to about 46 square feet per patient.

The use of corrugated iron brings quicker results and takes less transportation to get the material to the site, but the house is not so comfortable as wood, it being colder in winter and warmer in summer. On the other hand, the fire risk is less for iron than for wood. At Bordeaux some two-story barracks were constructed because ground space was not available for single-story buildings and at Brest some large corrugated iron barracks were erected because needs were so urgent that time overruled every other consideration.

Dining rooms and kitchens.

15. As stated in the order quoted above, a building 20 by 100 feet was made to serve one company of 250 men for dining room and kitchen in Europe in the World War. This was supposed to be equipped with rough lumber tables and benches, but was not always so fixed. This kind of dining room was provided in divisional areas and in certain large depots with more or less permanent personnel. In replacement camps, rest camps, and debarkation camps, where large numbers of men were fed rapidly from one kitchen, other special types of dining rooms were developed. The plans on plates 24 to 26 of folio show what were considered the best developments. These did not provide seats. Men ate standing.

Screening.

16. In France there were few flies, comparatively speaking, and it was prescribed that screening would not be used except for operating rooms and kitchens in hospitals. After the armistice this was modified by screening being prescribed for kitchens and dining rooms at some of the ports, or where the warm climate made flies more prevalent. At the debarkation camp at St. Nazaire screens were not used, because, according to the commanding officer, flies could be controlled by cleanliness. Such large numbers of men were fed continuously that it was impossible to keep either the kitchens or dining places closed to flies, and screening was useless. At this place there were almost no flies. In warmer climates in America screening will always be demanded, although with rough construction it is very difficult to keep a house fly tight.

Windows.

17. In the World War glass could not be obtained. In addition, its transportation is always difficult. Various types of window substitute have been developed, either consisting of some kind of transparent cloth or tough paper or consisting of wire netting coated with a transparent film of gelatin substance, which may be inflammable or not or may be soluble in water or not. Window substitute transported in rolls provides a large amount of window material with little transportation space. Of course, the kind soluble in water should be avoided.

Water allowances.

18. The amount of water men use depends upon what they can get. While European cities use from 20 to 30 gallons per inhabitant, American cities use from 60 to 250 gallons per inhabitant. Men in camp will get along for cooking and drinking purposes alone (not including washing) on about 1 gallon per man per day. One camp in France, of about 20,000 men, had wash water 2 or 3 feet below the ground surface, and hauled for several months drinking and cooking water, getting along very nicely by hauling 1 gallon or less per man per day. The large debarkation camps in France had water supplies providing a maximum of 10 gallons per man. So 10 gallons or less per man or animal per day will take care of a camp quite nicely, although, of course, it will not provide for street sprinkling and such uses. Where water is piped to separate companies, one faucet per company can be made to serve, and no construction for washing face and hands is *necessary,* although it is sometimes provided.

Bathhouses.

19. In the divisional areas in France one bathhouse per battalion area was provided. It had a "bain douche" of 8 showers, and was a house 12 by 23 feet, with a partition giving a room 8 by 12 feet for the shower and a room 12 by 15 feet for dressing. When practical, a 4-inch concrete floor was put in the shower room and a wooden floor in the dressing room. The "bain douche," a French affair, is a most economical device in matériel and in water used. The above-mentioned allowance is quite small and requires good administration and supervision in the use of a bathhouse by a company, and requires bathing by squad. Somewhat better facilities were provided in some large camps, but the above represents *bare necessity.* A type of bath providing better facilities than that described above is shown on plate 27 of folio.

Drainage.

20. In camps drainage should be by open ditches and piping should not be used.

Latrines.

21. Latrines should be of simplest type. About one seat to 20 men is desirable, although one seat to 40 men can be made to serve. No floor or concrete is necessary around a latrine. A roof with enough siding for a screen is desirable although by no means an absolute necessity. The French squat latrine is shown on plate 28 of folio. It is economical but does not conform to American standards of comfort. The American seat latrine is shown on the same plate. More elaborate latrines are shown among the hospital drawings on plates 44, 63, 106, and 110 of folio. Whether a latrine has sides, roof, and seats depends upon availability of material.

No sides or roof at all, or simply pieces of canvas or brush, are frequently made to serve. In war, water-borne sewerage, septic tanks, and other sewage-disposal devices should be avoided, as there are never materials or labor available for such purposes.

Electric lights.

22. Where electric power and materials for lighting are available, it is a convenience to have electric lights in a camp, and they may be installed. However, such installations are made only when the facilities for their construction are easily available. When camps are lighted there need not be over four 25-watt lights per barrack (20 by 100 feet), and one 25-watt light per officer. Ordinarily in war only divisional headquarters and other higher headquarters have electric lights. A divisional headquarters has lights which require about 3 kilowatts.

Laundries.

23. The use of laundries in the A. E. F., except for troops going in and out of the front line and for hospital patients, was forbidden.

HOSPITALIZATION.

Percentage of hospitalization for a military force.

24. In the beginning hospital provision to accommodate 7 or 8 per cent of the personnel in France was authorized by General Headquarters, A. E. F. This was to be obtained by renting existing buildings and by new construction. Later this percentage was increased until it became 15 per cent. Just before the armistice the sick and wounded increased rapidly and became 12 or 13 per cent. The combination of flu and desperate fighting accounts for such a high percentage of hospital patients. It is believed that it must be a most desperate war in which hospital provision of over 10 per cent is necessary. When fighting is not severe and not continuous, 5 or 7 per cent ought to be an ample allowance. A divisional training area in France was allowed a camp hospital of 300 beds—i. e., 300 beds to 26,000 men, or a little over 1 per cent.

Space allowances—Type plans.

25. Plans of the hospitals constructed at Bazoilles and at Beaune, France, are shown on plates 29 and 30 of folio. On plates 31 to 94 are shown the type plans (designated Type A), that were used for base hospitals, and all their features. These hospitals were constructed in 1,000-bed units and the drawings show several different kinds of units (designated layouts A, B, and C), made up of different sized buildings. As mentioned above, the space allowance per patient as prescribed was 60 square feet, but later instructions to provide for 1,200 beds in the so-called 1,000-bed units made the actual allowance from 46 to 54 square feet per patient. The follow-

ing shows the space devoted to each facility in the base hospital according to the type plans.

	Layout A.			Layout B.			Layout C.		
	Total square feet.	Square feet per patient.		Total square feet.	Square feet per patient.		Total square feet.	Square feet per patient.	
		1,000 patients.	1,200 patients.		1,000 patients.	1,200 patients.		1,000 patients.	1,200 patients.
Wards	56,160	56.1	46.8	65,600	65.6	54.7	65,600	65.6	54.7
Kitchen and dining-room latrines	5,616	5.6	4.7	5,920	5.9	4.9	5,616	5.6	4.7
Feces destructors	674	.7	.6	674	.7	.6	674	.7	.6
Bath	1,512	1.5	1.3	1,512	1.5	1.3	1,512	1.5	1.3
Recreation	2,368	2.3	1.9	2,368	2.4	1.9	2,386	2.4	1.9
Total for patients	66,330	66.3	55.3	76,074	76.1	63.4	75,770	75.8	63.1
Administratives	2,000	2.0	1.7	2,000	2.0	1.7	2,000	2.0	1.7
Receiving and evacuating	1,512	1.5	1.3	1,512	1.5	1.3	1,512	1.5	1.3
Laboratory and morgue	800	.8	.7	800	.8	.7	800	.8	.7
Operating and clinic	4,536	4.5	3.8	5,400	5.4	4.5	4,536	4.5	3.8
Stores	5,616	5.6	4.7	6,400	6.4	5.3	5,616	5.6	4.7
Disinfector	920	.9	.8	920	.9	.8	920	.9	.8
Electric plant	520	.5	.4	520	.5	.4	520	.5	.4
Total overhead	15,904	15.9	13.2	17,552	17.6	14.6	15,904	15.9	13.2
Total for nurses	12,640	12.6	10.5	12,640	12.6	10.5	12,640	12.6	10.5
Total for personnel	11,266	11.2	9.4	11,150	11.1	9.3	11,150	11.1	9.3
Grand total	106,140	106.1	88.4	117,416	117.4	97.8	115,464	115.5	96.2

26. The figures above show that there was provided for the actual use of a patient from 55 to 76 square feet of space. This figure corresponds to the figure of 28 square feet which was provided for the ordinary soldier. The overhead space in the base hospital units varied from 13 to 17 square feet per patient, and the total space per patient, including space of attending personnel, was from 88 to 117 square feet.

27. The attending personnel were supposed to have exactly the same allowances as all other Army personnel, but they sometimes had more. For instance, the ablution room, a convenience but not an absolute necessity, shown on type plans, was something that other soldiers did not receive, and it might well have been omitted in hospitals. Likewise, the baths for enlisted and commissioned personnel were more elaborate than other Army personnel had.

28. On plates 100 to 117 of folio are shown type plans for camp hospitals (designated type B). The following shows the space devoted to each facility in this kind of hospital:

	Total space.	Square feet per patient.	
		300 patients.	500 patients.
Wards	20,000	66.6	40.0
Kitchen and dining room	2,000	6.6	4.0
Latrines, feces destructors	518	1.7	1.0
Baths	560	1.8	1.1
Total per patient	23,078	76.9	46.1
Administrative	986	3.3	2.0
Laboratory, morgue, disinfector	1,040	3.5	2.1
Operating and clinic	2,000	6.7	4.0
Stores	1,070	3.5	2.1
Total overhead	5,096	17.0	10.2
Total per personnel	4,286	14.3	8.6
Grand total	32,460	108.2	64.9

29. The figures above show that for the actual use of a patient the camp hospital provided from 46 to 77 square feet. This figure corresponds to the figure of 28 square feet which was provided for the ordinary soldier. The overhead space in the camp hospital varied from 11 to 17 square feet and the total space per patient, including space of attending personnel, was from 65 to 108 square feet.

30. The attending personnel in camp hospitals, as well as base hospitals, was supposed to have the same allowances as all other Army personnel. The ablution room, a convenience but not an absolute necessity, in the camp hospital appears to be in excess of what other Army personnel received in France. Only one bathroom is provided for both patients and attending personnel.

Water supply and sewerage.

31. In France water supplies for base hospitals were designed on the basis of 25 gallons per patient, but not always was so much water available. Latrines with cans were used, the contents from the cans being generally burned. Feces destructors used are shown on plates 70, 93, 107, and 111 of folio. Drainage pipes for wash water and urine were laid. This is believed to have been a mistake. Piping for drain water and not for sewage is not worth the labor and material involved, and there was not enough water to permit of sewage being carried into the drains. An enormous amount of labor and material would have been conserved if no such drainage had been attempted. Stationary washbasins could have been dispensed with, and tin basins on a bench substituted. Sinks shown on type plans can be improvised from any materials available.

Electricity.

32. The electric lights placed in each ward should not exceed six. The power provided has to be suitable in voltage and sufficient to meet the requirements of the medical apparatus in the operating rooms.

REMOUNT DEPOTS AND VETERINARY HOSPITALS.

33. A large program of remount depots and veterinary hospitals was carried out in France, although the scarcity of animals hardly warranted so much construction. Layout on page 118 of folio shows a typical remount station and a typical veterinary hospital constructed at Gievre, France. Both of these used existing roads and avoided road construction. A typical horse shelter is shown on plates 119 and 120. Round poles can be used for posts when squared timber is scarce. Also hay racks and horse troughs can be placed on the ground and made of corrugated iron where lumber is scarce. A horse dip is shown on page 121 of folio. Disinfecting or sulphur chambers are constructed with any material available. They are nothing more than fume-tight houses in which animals are backed into stalls and the doors closed, with heads of animals projecting outside.

AIR SERVICE CONSTRUCTION.

34. The Air Service may require special construction at assembly plants, training centers, depots, and landing fields, in addition to provisions for personnel.

Assembly plants.

35. If aeroplanes are delivered unassembled, as they were in France, an assembly plant will be necessary. In France this plant was located where parts arriving at all ports could be collected. It was laid out on a very large scale and constructed progressively by unit, so that it could function to meet immediate needs. The units used were assembly shed with motor-testing adjunct, salvage shed, shop, store sheds, hangars, and landing field. The layout used in France is shown on page 122 of folio.

36. One assembly shed was composed of three houses 50 feet wide by 500 feet long placed side by side, and five houses placed perpendicular to these from 50 to 110 feet wide and about 350 feet long. In the three sheds first mentioned the planes were unpacked and partially assembled. They were then moved into the perpendicular sheds, where the wings were put on. The width of these sheds varied to suit different-sized planes, and it was expected that planes might finally be received having a width of 100 feet. It was claimed that floors were necessary in these sheds, but the planes were assembled without floors, although certain parts of the sheds were finally floored with concrete to facilitate work. Between the sheds forming the unit the valleys in the roof were covered and water was carried

off by simple wooden troughs. The sheds were generally steel frames covered with corrugated iron, although some were made of wood.

37. The salvage shed was identical with the assembly shed.

38. The shop was a building about the same size as the assembly shed. On account of machinery being used, concrete floors were greatly desired, and were partially laid, although they were done without for a while. Power was furnished by a 50-horsepower gasoline unit at first. More power was to be added.

39. Store sheds about 50 by 500 feet were used to store parts in. They were simple sheds without floors, containing certain racks to fit special parts.

40. A landing field adjacent to the plant was used on which to test planes before they were sent to the front. Hangars were placed on the side of this field.

Training centers.

41. The training centers in France contained provisions for personnel (which were supposed to be the same as for all Army personnel), landing fields with hangars, and shops for minor repairs.

Depots.

42. Air depots in France were located separate from general depots because the air supplies did not follow the same lines of travel as other supplies. The depots had store sheds without floors, the same as used in general depots. On plate 123 of folio is shown an advance depot constructed at La Trecey, France. This depot has shop buildings for repairs and a flying field. Some figures as to space requirements for storage are given in Table VII, following.

Landing fields.

43. Landing fields were constructed at assembly plants, at training centers, and behind the front. Some of these were located where woods had to be cut down and grubbed; others were more properly located on open ground, where smoothing only was necessary.

44. These fields have to be made smooth and planted in grass. Preparing a field is a long job and should be carefully considered and found necessary before being started. Plows, scrapers, graders, rollers, and tractors are used. A large 75-horsepower tractor, with a grader having a 12-foot blade, will do such work, or it can be done with smaller apparatus. Small Grey tractors were used to a great extent in France.

Hangars.

45. Hangars can be made of steel, wood, or canvas. Canvas, of course, is most expedient, but where long use is assured, or where extremely wide spans are required, wood or steel is used. The Bessaneau hangar, used in France, consisted of a light wooden truss covered with canvas. It had widths as great as 23 meters. This

type of hangar is the most economical in material and in transportation, and it can be easily moved. Spans under 70 feet can be made with wooden trusses. Greater spans than this make steel almost essential, and even smaller spans may make steel more expedient. Drawings of steel hangars are shown on pages 124 to 131 of folio. These are American designs, and are probably stronger and more durable than is absolutely necessary for war.

MOTOR TRANSPORT CONSTRUCTION.

46. Motor assembly plants, shops, and parks are necessary for automobiles and trucks in war. Each port in France had an assembly plant. There was one large shop in the intermediate section, and parks with shops were scattered throughout the advance section behind the front. All these layouts contained similar structures, varying in size. The construction work was building sheds, roads, and storage parks. In Table VII are given some figures as to space requirements for motor storage.

Sheds.

47. The sheds were made of both wood and steel. Sometimes they had concrete floors and sometimes they did not. Sheds were permitted only for work and for storage of spare parts. All vehicles were stored outside.

Roads.

48. Heavy traffic around motor facilities requires much road work. It has to be done with dirt, gravel, or rock, whichever is most available. Drainage is exceedingly important, because with good drainage almost any material will do well. Road work for any purpose is drainage and rock, and in war whatever is available must be used, with drainage always in mind.

Parks.

49. Storage ground for motor vehicles in France was sometimes graded and drained, but it was rarely surfaced with rock or gravel. Generally, grading for drainage will keep the ground firm enough to permit storage of motor vehicles; and only those portions of a park which are subjected to traffic have to be surfaced with rock. However, at places in France mud became so bad that tractors had to be used to move motor vehicles.

SUPPLY.

50. The British found the requirements for their army in France varied from 28 to 30 pounds per man per day. The experience of our Army indicated a larger figure (about 36 pounds) than this, but we were storing up a large 90-day reserve all the time, and were constructing a storage therefor. In addition, we never got a regular basis of supply for a fixed number of men. It is considered that

30 pounds per man per day is an ample allowance for planning for an ordinary expedition, and that 40 pounds per man is sufficient for any contingency. The figure, of course, depends upon the reserve planned for.

51. The plan of storage for our expeditionary force in the World War was first to have a reserve supply of 90 days for 2,000,000 men. Later this was changed to 45 days' supply for 4,000,000 men. One-half of this was to be stored in the base sections near the ports, one-third in the intermediate section, and one-sixth in the advance section. In order to handle and care for such a large supply, extensive port, railroad, and storage plans were necessary.

PORT CONSTRUCTION.

Dock requirements.

52. Experience of the British and American Armies showed that there could be unloaded 1.25 tons per day per linear foot of dock. On the basis of 40 pounds per man, 1,600 feet of dock length would supply 100,000 men, and 16,000 feet would supply 1,000,000 men.

Dock-handling apparatus.

53. In France there was great difference of opinion as to the advisability of installing cargo-handling apparatus, and the kind of such apparatus most expedient. Large Gantry cranes straddling three tracks were advocated by some, smaller cranes straddling only one track were advocated by others, and others advocated only ships' tackle. At first only ships' tackle was available. On the large dock at Bordeaux large Gantry cranes were later partially installed. Other derrick devices lighter than Gantry cranes were tried, with differences of opinion as to results. It is fairly certain that military necessities will have to be first met with no dock-handling devices at all, and if civil practices come in later, when tonnage is sufficient to supply them in addition to necessities, they can be designed according to existing conditions. In France the railroads never succeeded in removing all the supplies from the docks, so the unloading of the ships was not the critical feature.

54. At Antwerp, Belgium, a wharf used by the A. E. F. after the war had handling equipment that is considered reasonable if devices other than ships' tackle are possible. This wharf had a space 55 feet wide between the classification shed and the front of the wharf, with three railroad tracks on it. The outer track was spanned by a crane, so material, such as rail, iron, and steel, could be loaded direct from ship to flat cars. A cargo requiring classification could be deposited on a one-horse truck, which would carry it into the large classification shed on the rear of the dock and deposit it where it was desired. Railroad tracks were located also on the far side of the classification shed so cars could be loaded therefrom. The principle

of this dock, by which, in addition to railroad cars, liberal use can be made of horses, trucks, or men to move stuff away from the ship's side, is good.

55. The questions of ballast of ships, coaling, unloading exceptionally heavy pieces, etc., are problems which require special solutions, depending upon existing local conditions.

Dock construction.

56. Any rapid wharf construction, and rapidity of construction will certainly be necessary in military operations, must be wooden construction, and probably it will be pile construction. A pile wharf is the quickest and most economical in materials. The Montoir Pier, shown on plates 132 to 136 of folio, is considered the best type of work of this kind done in France from a military standpoint.

RAILROAD FACILITIES.

Facilities in general necessary.

57. In any theater of operations the main lines of communication will utilize existing railroads, and these will ordinarily be found adequate, in so far as main-line tracks are concerned, but, as in France, extra facilities may be found necessary. Ordinarily, construction necessary will be included in one of the following classes:

Passing tracks.
Tracks on docks and from docks to yards.
Receiving, classification, and departure yards, near docks, at engine terminals, at depots, or at any place where trains are made up.
Engine terminals.
Water tanks.
Railroad shops.
Regulating stations.
Railhead sidings.

Weight of rail.

58. In France practically all the railroad laid was in the form of yards and sidings. Although several lines, 10 or 15 miles long, were constructed to connect wharves with storage yards, or aviation centers with main lines, this was the exception rather than the rule. Since in yards and on sidings trains move slowly, it is not necessary to have as heavy rail as on main lines. In France 80-pound rail and 14 ties to the rail were used. It would have brought about a great saving in tonnage if about a 60-pound rail had been used, and rail of this weight would have served the purpose. Perhaps 16 or 18 ties to the rail would have been advisable for the lighter rail, but nevertheless the resulting saving in tonnage and transportation would have been enormous.

Passing tracks.

59. These need no special mention. They are simply added when and where traffic demands them.

Tracks on docks and from docks to yards.

60. There are usually at least three tracks used on a dock in front of the classification shed to take the cargo direct from ship. With three tracks cars can stand on one to receive loads and be moving on and off on the other two. If rails are laid at floor level, supplies can more easily be moved by animal, by truck, or by hand truck off the dock into the classification shed. Back of the classification shed there should be two or more tracks to receive cargo from this shed. Two or more tracks should be laid from the dock to receiving, classification, and departure yards. The layout of the Bassens terminal yards near Bordeaux is shown on plate 137 of folio.

Railroad yards.

61. At places where trains are made up and at depots, receiving classification and departure yards with tracks from 1,500 to 2,000 feet long are necessary. Tracks in France were spaced first with 14-foot centers, then with 16 foot centers, to permit locomotive cranes on hand to be used. While plans should be made providing for ultimate expansion into elaborate yards, the construction should be carried on progressively to fit immediate and urgent needs. In France plans were never completed entirely. Supplies moved eastward only, and all types of cars were used for any and all purposes indiscriminately, so the need for classification westward did not exist, since only empties traveled in that direction. The following is about the way yards should be developed, assuming loads are to move only in one direction (eastward, for instance):

62. Eastbound receiving yard: First installation, three tracks; more to be added as necessity develops.

63. Eastbound classification yard: First installation, eight tracks; more to be added as necessity develops.

64. Hump between receiving and classification yard, a by-pass around hump to be added when practicable.

65. Eastbound departure yard and another classification yard will be added to meet demands, the tracks being increased as necessity develops. At first one receiving yard and one classification yard will be used for receiving, classification, and departures in both directions. Finally, westbound receiving and departure yards may be used, but the necessity for westbound classification may not develop. It depends upon the location and conditions whether one yard with many tracks is used for receiving and departure or whether the tracks are divided into two yards.

66. The layout used at Gievres, France, shown on plate 138 of folio, served the intermediate depot; served as an engine terminal;

and during the German attacks near Château-Thierry served as an advance depot and regulating station for the Paris group of American forces. In other words, these yards were made to serve every requirement under most difficult conditions. They were constructed on the principles outlined above. One track (about 1,700 feet long) along one side of the storehouses was found sufficient. The yard was designed with the idea that each storehouse was similar to a freight storehouse in New York, Chicago, or San Francisco, where freight comes in and goes out of the same house at the same time. In such a storehouse freight comes in for Jones, Smith, etc., at the same time that it is going out for Thompson, Jackson, etc., so the facilities for handling into the house from cars and out of the house into cars at the same time are necessary. At Gievres it was different. Everything that came in was for Uncle Sam and everything that went out was for Uncle Sam, and practically everything that came in on the railroad went out on the railroad. One house generally carried only one article, and if that article was to be shipped to Uncle Sam, the same article, if in cars to be unloaded, would simply be reconsigned in the same cars without unloading. The entire yard of about 125 storehouses was just as if it were one house with many tracks through it. Unloading and loading from the same tracks was never necessary because each particular item was always stored on more than one track. Items coming in would be unloaded on entirely different tracks from the one on which loading was necessary. In the area where wagons were unloaded, assembled, and then reloaded for the front, three adjacent tracks and a locomotive crane were used. Of course, such a layout as this is constructed as the facilities are needed, and where topography makes construction difficult that part of the yard is simply omitted and extensions are made where construction is easy and rapid. Ballasting was not done here at all, and is never done until it is demonstrated to be necessary.

Engine terminals.

67. On a main line engine terminals are placed about 75 or 100 miles apart. These terminals consist of receiving yard, turntable or wye, ashpit, inspection pit, water tank, coaling facility, engine house, boiler house, oil house, standing tracks, and departure yard. A classification yard is necessary only if trains are broken and made up anew at the terminal. A layout used at Saumar, France, is shown on plate 139 of folio.

68. The yards are constructed progressively to meet demands.

69. Ashpit is shown on plate 140. Ashes are handled by hand. If concrete is not available this pit can be made with old ties.

70. Inspection pit is shown on plate 141. If concrete is not available this pit can be made with old ties.

71. Coaling facility is shown on plate 142. At Gievres the coal was simply put in a pit dug in the ground without the lumber work shown on the drawing.

72. Engine house is shown on plate 143. This plan follows civil practice. It should have consisted of simple sheds, containing each about two tracks. Thus there would have been light from the sides, and the complicated sawtooth construction requiring glass would have been avoided.

73. Boiler and oil houses should be simply corrugated forms of houses.

Water tanks.

74. Water tanks have to be placed on main lines about every 10 or 15 miles apart, at engine terminals, and at places where switching is necessary. A tank design following standard civil practices is shown on plate 144 of folio. However, tanks can be improvised from any lumber available. A plank 3 inches thick is desirable. When tank has to be improvised, 25,000 gallons is a convenient size. Posts for such a tank can be 8 by 8 inches, resting on wooden blocks instead of concrete. Any available iron rods can be used for bands. If turnbuckles are not available, a substitute can be improvised by taking a piece of pipe, mashing it together in the middle longitudinally, and passing the rods through the two tubes thus formed and securing them with nuts on opposite ends. If regular crane and large pipe is not available, 4 or 6 inch pipe and fittings can be used.

Railroad shops.

75. Existing shops will probably be used, but they may require additions and improvements to meet conditions of extra traffic.

Regulating station.

76. A regulating station is nothing more than yards to receive, classify, and make up trains for serving troops with a daily automatic supply. Cars containing complete rations are made up into trains, so that cars for one unit, generally a division, can be easily shifted out of a train. Supplies for a division for one day, other than ammunition, generally require cars carrying from 50 to 80 tons. The regulating officer receives requisitions from troops and supervises the making up of trains. A regulating station may or may not be at the same place as the advance depot. A layout of a combined regulating station and advance depot is shown on plate 145 of folio and a regulating station without advance depot is shown on plate 146.

Railhead sidings.

77. Where a division receives its supplies, sidings and storehouse space are necessary to only a limited extent. As the supply is

automatic and daily, usually store space for one or two days' supply with corresponding sidings is sufficient. A railhead used at Sorcy, France, is shown on plate 147 of folio.

OIL AND GASOLINE STORAGE.

78. In France tanks and tank cars were used for gasoline only. In order not to have to clean tanks, heavy oils and greases were transported and stored in containers.

Large tanks.

79. Fifty thousand barrel storage tanks were erected in several places in France. Near the ports additions were made to existing commercial plants, and the tanks were erected on concrete foundation. These foundations near water were not considered safe without concrete. At Gievre tanks were placed on the natural ground. A railroad siding was necessary, and pipe connections from tanks to cars. The Gievre layout on plate 138 includes a gasoline and oil depot.

Small tanks.

80. A large number of small tanks were fabricated at Gievre and were sent all over France for use at gasoline-filling stations.

AMMUNITION DEPOTS.

81. Depots for ammunition other than small-arms ammunition are constructed separately from general depots.

Layout.

82. In France advance ammunition depots were so laid out that each storehouse (about 50′ by 500′) was located apart from other storehouses. Intermediate and base depots were first laid out with the storehouses in groups of eight houses, each 50 by 1,000 feet. Later the depots in the rear were designed on the same principle as the advance depots. On plate 148 of folio is shown layout of the first intermediate ammunition depot constructed, and on plate 149 is one constructed later at Issoudun. The advance ammunition depot is shown on plate 150. A bomb and grenade depot is shown on plate 151.

Railroad yard.

83. Although yards of 11 or more tracks were planned in France, 5 tracks filled every need which developed. A water tank near the yard was found necessary.

84. The sheds for ammunition are the same as the sheds for general stores shown on plates 154 and 155 of folio. Designs of sheds, with earth protection on the sides and overhead, were made in France, but there was never material and labor for such construction. Such

a storehouse would simply make an explosion more disastrous, if it occurred, as the earthen walls and roof would act as tamping for the explosive. Safety is gotten by separating the ammunition so as to localize any explosion. Intermediate and base depots are located beyond the range of hostile aeroplanes, so protection for them is not logical. Separation of storehouses gives a certain amount of concealment from aeroplanes. As a matter of fact, a great deal of the ammunition in the World War was stored outside, and this can be done in any war if materials and labor are too scarce to permit of the construction of storesheds. If sheds are constructed, it is not necessary to build the ground in them up to car level, since in war manpower for operations is always more plentiful than building facilities. It is important to get something that can be used quickly and to give little weight to number of men necessary for operation.

Electric lighting.

85. At the advance depot in France electric lights were installed in the sheds, and power units were placed on push cars so that they could be placed on tracks adjacent to shed and connection made to lighting wires. It is rare that loading is going on from more than one or two sheds at the same time at night. At intermediate and base depots night work will rarely be necessary, so electric lights are not essential.

Personnel.

86. The operating personnel for an ammunition depot in France was about 1,000 men, and camps for them were located on existing roads near by. It is better to locate men in separate small camps, if possible, so that there are workmen near all parts of the depot.

GENERAL STORAGE DEPOTS.

Plans and development.

87. All supplies other than ammunition, aeroplanes, and motor vehicles will ordinarily be stored in general storage depots, whose location will depend upon conditions. The plan on plate 138 of folio shows the storage depot at Gievres, France, in the intermediate section. This layout was used most in France and was successful. It was constructed progressively according to immediate and urgent needs and was never completed according to plan.

88. The storehouse area is laid out in sections, each section having a ladder track on each side connected by house tracks about 1,700 feet long, there being one of these to each three warehouses. These tracks are about 150 feet apart, which gives space enough for open storage on the opposite side of the track from the houses, as well as space for fire breaks. A section can be started with a ladder track on one side, the ladder on the other side to be added later. Running tracks are added when found necessary.

89. The plan on plate 152 shows the depot at Montierchaume, France, which depot was planned after experience had shown the proper methods of development. This layout shows spaces assigned to each department, coal tracks, hay tracks, explosive spur, etc. This depot was developed on the proper principles. The drawing on plate 153 gives more detail and also shows what was actually done at the end of the war.

90. In constructing a storage depot, in the beginning the space should be laid out in separate areas for each department of the Army, in the proportion of the tables which follow, and the construction should proceed so that each department can begin storing supplies and expand without mixing up its supplies with those of other departments. At Montierchaume all the railroad sections were started at the same time, so each department could start and have its own expansion area.

91. In addition, different types of storehouses should be distributed on separate tracks, so that any one commodity can be stored on separate tracks; this so that, if desirable, the same commodity may be loaded from one track while it is being received on another.

92. The grouping and building of houses should more or less fit departmental organizations when practicable. For instance, the Quartermaster desires his rations and his clothing in separate groups which can expand simultaneously.

93. In constructing the yards, no existing roads should be closed by warehouses or tracks, as roads are almost impossible to construct with the means at hand, and available roads should be used.

94. Each department will desire one or more storehouses from which shipments can be made by truck. These warehouses should be selected adjacent to existing roads, so that each department has one warehouse on a road. At Montierchaume wagon yards and open Engineer storage were distributed throughout the depot to make fire breaks between the storehouses.

95. In addition to the departments shown in the tables hereafter, there are a number of small additional departments which may require space in a depot for a force of a million or more men, viz, Red Cross, 25,000 square feet; Y. M. C. A., 50,000 square feet; American Library Association, 20,000 square feet; and fire prevention, 25,000 square feet. Usually these departments desire storehouses along an existing road, so that their storage will be accessible for trucks.

Fire protection.

96. In the design of the depots the warehouses are intentionally spaced far enough apart so that fire can not spread from one to another, and groups of warehouses are separated by open storage spaces. In addition, much of the contents of the warehouses is

not inflammable, and generally the warehouses are built of corrugated iron and are not extremely inflammable. No artificial fire protection is necessary. The cost of such a system in material far exceeds any probable loss from fire. Fire should be prevented from spreading by keeping the areas between the warehouses clear of rubbish and inflammable material. To lower the fire risk, all offices and facilities which use fires should, whenever practicable, be located outside of the sections which contain warehouses.

97. At Montierchaume wagon yards and open Engineer storage were distributed throughout the depot to make fire breaks between storehouses.

Hay and dynamite.

98. Sidings or spurs far removed from other stores are laid for the storage of hay and dynamite; this for localizing fire risk.

Coal pile.

99. A reserve coal pile in addition to the coaling facility for locomotives may be necessary. Such a pile is formed by unloading by hand from two or more tracks. As the coal increases the tracks are raised until the pile gets about 10 feet high at the higher end, then a new pile is started. Cars standing on tracks laid on level ground alongside such a coal pile can be loaded with coal when it is desired for use. Coal piles such as described may catch on fire inside; for this reason their height should be limited to about 10 feet and they should have spaces between them. If fire develops, it has to be stopped by digging around the fire and localizing it.

Warehouses.

100. The storehouse most used in France was 50 feet wide and 400 or 500 feet long. It was made with wooden frame and corrugated-iron roof and sides. The two types used are shown on plates 154 and 155 of folio. Type "B" is easier than type "C" to construct but not so strong. Both houses have very small factors of safety and should be strengthened if used where large wind or snow loads are expected. In France frequently no sides were put on these houses, and they were used as sheds. Sides were placed only on the houses which carried perishable supplies, such as flour or sugar. In place of windows, when siding was used it was simply carried up to within about a foot or 18 inches of the roof, and a continuous opening was left at the top, which was protected by the eaves. Doors were generally not used, canvas being placed over openings where it was necessary to close them. Of course, this did not contemplate protection from theft except by guarding. The frames of buildings were made with round posts and rough lumber. Mostly no floors at all were placed. Dunnage was used to keep supplies off the damp ground. Supplies very sensitive to water, such as

flour and sugar, were placed on a floor or dunnage consisting of wood poles with rough-edged plank laid on them. Economy in labor of operations is of minor importance in war, so floors at car level do not warrant the labor, materials, and time necessary to construct.

101. In addition to the flimsy structures described above, there were used in France some all-metal warehouses of the same sizes as the wooden framed ones. One type of steel building came from America and another type came from England. The two types illustrated the difference in proper constructing methods in peace and in war. The American building was perfectly safe and was good for many years. The English building had a very small factor of safety and was good for only one or two years. The American building consisted of many different and noninterchangeable parts, while the English building had more simple parts. One hundred such American buildings were received in France, and they were of different designs. It proved exceedingly difficult to get the parts of any one building together. In addition, some parts were so heavy that handling was very difficult. These buildings should have all been of the same design, their parts should have been as nearly interchangeable as possible, and there should have been as few unlike parts as possible. The parts should have been light, and the entire building could have been much lighter and less durable, thereby saving labor, material, and time.

102. In war materials are necessarily scarce, and just as no labor-saving construction is warranted, likewise absolute safety from fire, theft, and weather is not as important as in peace time, since everything is more or less temporary and chances must be taken. Forty per cent of the rations and a large proportion of other stores can be stored outside for periods of two or three months without any appreciable loss. It is useless for the supply features in war to play a perfectly safe game, when at the front large losses are a mere incident.

Cold storage.

103. Where soldiers are to have fresh meat, cold-storage plants may be necessary. These are used only to freeze or store meat between shipments, and not to store a reserve supply. Reserve rations are kept in the form of canned meats. In France some plants of this kind were built. The one at Gievres, with rated capacity of 5,000 tons, stored at times 6,500 tons of meat, it being piled in quarters with 2 by 4 inch strips in between. The floor space used was 896 by 110 feet, with about 11 feet head room. This makes the area occupied from 15 to 20 square feet per ton stored. These plants were first designed in the same way that they are designed in civil practice. Later they were modified, and when built the ice-freezing feature was omitted entirely, spare boilers were omitted, and water for condensing pu poses was omitted. While such a structure, on account of its

technical nature, must be most carefully constructed, a designer having in mind the military requirements of simplicity, economy of materials and time, and the lack of durability, can modify for the better the structure designed from civil experience. Cold-storage plant drawings are shown on plates 156 to 159 of folio.

Bakeries.

104. If the depot is required to make automatic shipments of rations to the front, bakeries may be necessary. It is necessary to carefully consider their location with reference to water, since the water requirements of a bakery are very large. In war, where simplicity is the rule, a corrugated-iron house for each bakery company to operate in is better than attempting any complicated mechanical bakery affair. The house can be constructed to fit the bakery organization. Sometimes it is difficult to get fire brick desired for use with the field bakeries, but as they are supposed to operate in the field, the lack of such brick should not be serious.

Coffee-roasting plant.

105. In France the Quartermaster started buying green coffee, which necessitated coffee-roasting plants at some of the depots. Where 30,000,000 rations were stored, the coffee-roasting house was about 20,000 square feet in area. The machinery is sometimes operated by electric power and sometimes by steam power.

Freight house for small shipments.

106. The depot will probably have to make a larger number of less than carload shipments from the various departments, and it will probably be necessary to use about 15,000 square feet for a shipping warehouse for less than carload shipments. This warehouse should be located near a connection to the main-line outgoing railroad.

Post warehouse.

107. The post, to serve the personnel which operated the depot, will need a warehouse for issue purposes. This warehouse should contain from 20,000 to 25,000 square feet and should be located on a road outside of the depot area, since it is important that the post issuing department should not be mixed up with the depot departments. This warehouse should be on a siding.

Offices.

108. Each department of the Army will need office space, which may develop to about the following for a depot carrying 30 days' supply for 1,000,000 men; Quartermaster, 8,000 square feet; Engineers, 6,000 square feet; Ordnance, 2,000 square feet; Medical, 2,000 square feet; Signal Corps, 2,000 square feet. The respective offices should be located outside of the railroad sections and adjacent to the areas occupied by the departments which they serve.

109. The operating personnel used at the intermediate storage depot at Gievres, France, which depot carried 30 days' supply for 1,000,000 men, was:

Quartermaster	8,308
Ordnance	513
Signal	524
Engineer depot	1,820
Medical	460
Chemical Warfare	44
Gasoline and oil	250
Y. M. C. A	88
Red Cross	31
Transportation	1,419
Construction	1,900
Miscellaneous guards, convoys, etc	6,250
Total	21,607

110. Camps for operating personnel should be located on existing roads, and should be distributed around the depot, so that personnel belonging to each department is within walking distance of its work. Such distribution lends itself also to sanitation and small fire risk.

Water supply.

111. In addition to water for personnel, there will be water for locomotives, and possibly ice plants and bakeries. One depot in France expected to use about 500,000 gallons per day. The personnel got water from wells, while the ice plant and locomotives were mainly supplied from a near-by river.

Electricity.

112. The working of labor at night is an uneconomical procedure, and is avoided as much as possible. Experience has shown that in the intermediate and base depots very little night work is necessary, so it is unnecessary to install electirc lights in the warehouses. On rare occasions when night work is necessary, acetylene flares can be used.

Storage space requirement.

113. The following tables show quality of storage, for various items of supply and space allowances found by experience to be necessary:

TABLE I.—*Classification of supplies for purpose of storage.*

QUARTERMASTER.

Materials for which continuous cover must be provided.	Materials which may be stored in open without serious deterioration.
Subsistence: Sugar. Flour. Rice. Subsistence not in tins. Oats and bran. Clothing and equipment. Fine hardware. Harness and accessories.	Subsistence: Tinned goods, except butter. Soap. Vinegar. Hay. Animal transportation. Miscellaneous supplies.
Percent of total bulk, 48.	Per cent of total bulk, 52.

TABLE I.—*Classification of supplies for purpose of storage*—Continued.

MOTOR TRANSPORT.

Materials for which continuous cover must be provided.	Materials which may be stored in open without serious deterioration.
Motor parts. Hand tools. Machine tools. Pneumatic tires. Tubes. Lamps. Horns. Tarpaulins.	Complete vehicles and chassis. Solid tires. Steel and iron shapes. Bows. Bodies.
Per cent of total bulk, 65.	Per cent of total bulk, 35.
ORDNANCE.	
General Ordnance property. Fixed artillery ammunition and powder charges. Stokes mortar bombs.	Small-arms ammunition. Projectiles. Hand grenades. Trench bombs. Guns, caissons, and limbers. Tractors. Helmets.
Per cent of total bulk, 50.	Per cent of total bulk, 50.
AIR SERVICE.	
Airplanes. Airplane engines. Spare parts. Photographic supplies. Clothing. Radio equipment. Small hardware.	Bombs and ammunition. Armament. Gasoline. Transportation.
Per cent of total bulk, 65.	Per cent of total bulk, 35.
MEDICAL.	
Medicine. Antiseptics. Disinfectants. Laboratory supplies. X-ray supplies. Surgical instruments and dressings. Dental supplies. Veterinary supplies.	Enamelware. Beds. Glass. Woodenware.
Per cent of total bulk, 85.	Per cent of total bulk, 15.
LIGHT RAILWAYS.	
Shop supplies. Fine hardware. Machinery tools. Hand tools.	Rolling stock. Track material. Tractors. Road machinery.
Per cent of total bulk, 4.	Per cent of total bulk, 96.
SIGNAL.	
Meteorological instruments. Telephone instruments. Telegraph instruments. Inside hardware. Electrical equipment. Field glasses. Watches. Clocks, etc.	Cable. Wire. Poles. Cross-arms. Lance poles. Pole fittings. Line hardware. Insulators.
Per cent of total bulk, 60.	Per cent of total bulk, 40.

TABLE I.—*Classification of supplies for purpose of storage*—Continued.

CHEMICAL WARFARE.

Materials for which continuous cover must be provided.	Materials which may be stored in open without serious deterioration.
Respirators. Chloride of lime. Bursting and propellant charges. Instruments. Blanket cloth. Alarm devices. Stokes mortars. Livens component parts.	Gas cylinders. Bombs.
Per cent of total bulk, 57.	Per cent of total bulk, 43.

ENGINEER.

Instruments: Electrical and mechanical supplies. Stationery. Cement. Fine hardware. Manila rope. Harness and accessories.	Building materials: Tar paper. Wall board. Corrugated iron. Generator sets. Sandbags. Pipe and pipe fittings. Road machinery. Tractors. Miscellaneous supplies: Shovels. Picks. Heavy hardware.
Per cent of total bulk, 10.	Per cent of total bulk, 90.

TABLE II.—*Space and quality of storage required for 30,000,000 rations.*

	Cubic feet per 100 pounds net.	Number of pounds in 30,000,000 rations.	Volume in 30,000.000 rations.	Height.	Area.	Aisle area.	Total area required.
			Cubic feet.	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*
Butter, lard, etc	3.62	1,070,000	38,900	6	6,450	1,290	7,030
Beans, issue	1.76	4,500,000	79,300	10	7,930	1,600	15,860
Bread, hard	5.55	30,000,000	1,665,000	6	277,500	55,500	333,000
Coffee	4.86	2,100,000	102,150	6	17,030	2,350	19,380
Flour	1.62	33,750,000	548,440	10	54,900	11,000	65,900
Fruit, canned	3.00	2,400,000	72,000	....	12,000	2,400	14,400
Fruit, dried	2.08	2,400,000	49,200	....	8,320	1,660	9,986
Meats, canned	3.33	30,000,000	999,000	....	166,500	33,100	199,600
Salt	1.43	1,200,000	17,160	....	2,860	570	3,430
Spices	7.80	60,625	3,946	....	658	132	790
Vegetables, canned	3.03	26,250,000	795,375	....	132,560	26,510	159,070
Vegetables, fresh	2.44	37,500,000	915,000	....	152,500	30,500	183,000

	Warehouse requirements.			
	Over 60 days.		Under 60 days.	
	Piled on—	Piled in—	Piled on—	Piled in—
Butter, lard, etc	Poles	House	Poles	Shed.
Beans, issue	Slabs or poles	do	do	House.
Bread, hard	Poles	do	do	Shed.
Coffee	do	do	do	Do.
Flour	Slabs or poles	do	do	House.
Fruit, canned	Poles	do	do	Open.
Fruit, dried	do	do	do	Shed.
Meats, canned	do	do	do	Open.
Salt	do	do	do	Shed.
Spices	do	do	do	Do.
Vegetables, canned	do	do	do	Open.
Vegetables, fresh	do	do	do	Shed.

TABLE III.—*Space and quality of storage required for forage.*

	Ration, unit.	Volume.	Height.	Area.	Aisle area.	Total area.	Warehouse requirements.			
							For under 60 days.		For over 60 days.	
							Piled on—	Piled in—	Piled on—	Piled in—
		Cu. ft.	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*				
Hay.....	1,000,000	523,000	20	52,300	10,500	73,000	Ground.	Open...	Poles....	Open.
Oats....	1,000,000	304,000	10	30,400	6,080	36,480	Slabs or poles.	House...	Slabs or poles.	House.

TABLE IV.—*Space and quality of storage required for 1,000,000 Ordnance equipments (personnel).*

	Volume.	Area piled 9 feet high.	Aisle area.	Total.	Warehouse requirements.	
					In boxes, piled on—	In boxes, piled in—
	Cubic feet.	*Feet.*	*Sq. ft.*	*Sq. ft.*		
Meat-can cover..........................	24,000	2,667	533	3,200	Ground...	House.
Meat can................................	83,000	9,222	1,844	11,066	...do......	Do.
Canteen cups............................	57,000	6,333	1,267	7,600	...do......	Do.
Knives..................................	1,500	167	33	200	...do......	Do.
Forks...................................	1,000	111	22	133	...do......	Do.
Spoons..................................	1,000	111	22	133	...do......	Do.
Bayonet and scabbard....................	46,000	5,111	1,022	6,133	...do......	Do.
Bolo and scabbard.......................	29,000	3,222	644	3,866	...do......	Do.
Bacon can...............................	50,000	5,556	1,111	6,667	...do......	Do.
Condiment can...........................	36,000	4,000	800	4,800	...do......	Do.
Canteen cover...........................	84,000	9,333	1,867	11,200	...do......	Do.
Gun slings..............................	7,200	800	160	960	...do......	Do.
Rear belt suspender.....................	4,000	444	89	533	...do......	Do.
Haversack and car.......................	150,000	16,667	3,333	20,000	...do......	Do.
Hand axes...............................	50,000	5,556	1,110	6,666	...do......	Do.
Magazine carrier........................	14,000	1,556	310	1,866	...do......	Do.
Pick carrier............................	20,000	2,222	444	2,666	...do......	Do.
Hand ax carrier.........................	24,000	2,667	533	3,200	...do......	Do.
Hatchet.................................	40,000	4,444	889	5,333	...do......	Do.
Hatchet carrier.........................	20,000	2,222	444	2,666	...do......	Do.
Shovel carrier..........................	20,000	2,222	444	2,666	...do......	Do.
Pistol..................................	81,000	9,000	1,800	10,800	...do......	Do.
Pistol holster..........................	70,000	7,778	1,555	9,333	...do......	Do.
Pistol belt.............................	20,000	2,222	444	2,666	...do......	Do.
Pouch, first-aid........................	5,000	555	111	666	...do......	Do.
Pouch, small articles...................	20,000	2,222	444	2,666	...do......	Do.
Rifle...................................	990,000	110,000	22,000	132,000	...do......	Do.
Trench knife............................	39,000	4,333	867	5,200	...do......	Do.
Hand rifle, gr. car.....................	60,000	6,667	1,333	8,000	....	
Total...................................	....	....	....	272,885	....	

TABLE V.—*Space requirement for horse ordnance equipment.*

STORED IN HOUSES OR SHEDS ON DUNNAGE.

	Unit.	Volume.	Area piled 9 feet high.	Aisle area.	Total.
		Cubic feet.	*Feet.*	*Sq. feet.*	*Sq. feet.*
Bridles (French)	5,000	1,800	200	40	240
Bridles (U. S. Cavalry)	5,000	1,100	122	24	146
Saddles (French)	5,000	9,000	1,000	200	1,200
Saddles (U. S. McClelland)	5,000	6,000	667	133	800
Saddles (mule)	5,000	5,000	556	111	667
Loose harness (French)	10,000	39,960	4,440	888	5,320
Leather, in bundles	10,000	270	30	6	36
Horse-cover blanket	10,000	3,600	400	80	480
Saddle blankets	10,000	2,880	320	64	384
Aparejos (pack outfit)	10,000	30,000	3,333	667	4,000
Feed bags (in boxes)	10,000	1,125	140	28	168
U. S. Artillery harness	10,000	112,000	12,444	2,489	14,933
Machine-gun harness box	10,000	68,000	7,556	1,511	9,067
Total					37,441

STORED IN OPEN.

Cartridge, 30-caliber	500,000,000	500,000	83,333	16,667	100,000
Pick mattock	1,000,000	70,000	11,667	2,333	14,000
Intrenching shovels	1,000,000	140,000	23,333	4,667	28,000
Wire cutters (American)	1,000,000	8,000	1,333	267	1,600
Helmets	1,000,000	207,000	34,500	6,900	41,400
Oil (gallons)	1,000,000	200,000			40,000
Total					225,000

TABLE VI.—*Space and quality of storage required for engineer depot for 30 days' supply for 1,000,000 men.*

	Square feet.	Warehouse requirements.			
		For under 60 days.		For over 60 days.	
		Piled on—	Piled in—	Piled on—	Piled in—
Machine shop and foundry	100,000	Ground	House	Ground	House.
Rail and forestry supplies	25,000	...do	...do	...do	Do.
Camouflage and electric supplies	25,000	...do	Shed	...do	Do.
Water supply	25,000	...do	...do	...do	Do.
Pioneer	25,000	...do	...do	...do	Do.
Searchlight	25,000	...do	...do	...do	Do.
Total	225,000				
Miscellaneous	5,000,000	...do	Open	...do	Open.

TABLE VII.—*Storage requirements for 30 days' supply for 1,000,000 men.*

[NOTE.—The requirements are dependent upon how long supplies remain stationary—i. e., some supplies do not require covered storage if they are to move within a month or two—so requirements are shown under two headings, viz, maximum and minimum. Requirements for various numbers of men and various times can by computed by taking the proper proportion of items in this table.]

	Maximum covered.		Minimum covered.	
	Covered.	Open.	Covered.	Open.
QUARTERMASTER.	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*
Sack	125,000		125,000	
Package	250,000		200,000	50,000
Canned	400,000			400,000
Miscellaneous subsistence	250,000		125,000	125,000
Clothing	575,000		325,000	250,000
Salvage	100,000		50,000	50,000
Animal transportation		500,000		500,000
Animal transportation, acc.	100,000		50,000	50,000
Oats	75,000		75,000	
Hay		150,000		150,000
Miscellaneous	250,000	1,000,000	125,000	1,125,000
Total	2,125,000	1,650,000	1,075,000	2,700,000
ORDNANCE.				
Personal equipment	275,000		150,000	125,000
Horse equipment	50,000		25,000	25,000
Salvage	50,000		25,000	25,000
Small arms, ammunition, helmets, etc.		250,000		250,000
Miscellaneous		200,000		200,000
Total	375,000	450,000	200,000	625,000
MEDICAL.				
Surgical supplies	25,000		25,000	
Drug sundries	100,000		25,000	75,000
Bedding, linen, etc.	50,000		50,000	
Issue house	25,000		25,000	
Furniture, fixtures, etc.	25,000			25,000
Iron beds, sterilizers, etc.		250,000		250,000
Miscellaneous	75,000	200,000	25,000	250,000
Total	300,000	450,000	150,000	600,000
SIGNAL.				
Electrical appliances, small hardware	75,000		50,000	25,000
Cable, poles, animal-drawn transportation		750,000		750,000
Total	75,000	750,000	50,000	775,000
ENGINEER.				
Machine shops, etc.	100,000			100,000
Engineer supplies	125,000	5,000,000	50,000	5,075,000
Total	225,000	5,000,000	50,000	5,175,000

SUMMARY OF ABOVE WITH ADDITIONS.

Quartermaster	2,125,000	1,650,000	1,075,000	2,700,000
Ordnance	375,000	450,000	200,000	625,000
Medical	300,000	450,000	150,000	600,000
Signal	75,000	750,000	50,000	775,000
Engineer	225,000	5,000,000	50,000	5,175,000
Motor Transport	390,000		390,000	(1)
Air Service	432,000	1,800,000	432,000	[1] 1,800,000
Chemical Warfare	18,000	10,000	18,000	10,000
Light railway	96,000	1,200,000	96,000	[1] 1,200,000
Grand total	4,036,000		2,461,000	

[1] Not usually located at general depots.

INDEX TO PLATES.

	Plate.
Typical layouts for camps	1
Camp layout, Le Mans	2
Four-man bunk	3
Type B Barrack—Lumber	4–5
Type C Barrack—Corrugated iron	6
Demountable barrack—Dodon	7–9
Demountable barrack—Adrian	10–13
Knockdown barrack	14–16
Demountable hut—Sykes	17–19
Nissen hut—Metal	20–23
Mess hall, 40 by 160 feet	24
Mess hall—Brest	25
Brick range	26
Shower bath	27
Latrines—French and American	28
Hospital at Bazoilles	29
Hospital at Beaune	30
Base hospital—Layout A	31
Base hospital—Layout B	32
Base hospital—Layout C	33
Base hospital—Ward 20 by 164 feet	34
Base hospital—Ward 36 by 156 feet	35
Base hospital—Administration building	36
Base hospital—Nurses' quarters	37
Base hospital—Nurses' dining room and kitchen	38
Base hospital—Officers' quarters dining room	39–40
Base hospital—Receiving and evacuating	41
Base hospital—Receiving and evacuating and bath	42
Base hospital—Patients' bath	43
Base hospital—Latrines and bath	44
Base hospital—Recreation hall	45–46
Base hospital—Nurses' club	47
Base hospital—Laboratory and morgue	48
Base hospital—Operating and X-ray	49
Base hospital—Operating, X-ray, and clinic	50
Base hospital—Dispensary and clinic	51
Base hospital—Clinic and surgical dressings	52
Base hospital—Patients' kitchen	53
Base hospital—Kitchen and dining halls	54
Base hospital—Patients' dining room	55
Base hospital—Quartermaster stores	56
Base hospital—Quartermaster medical stores	57
Base hospital—Barracks	58
Base hospital—Personnel dining hall	59
Base hospital—Medical storehouse	60
Base hospital—Disinfector	61
Base hospital—Ablution building	62
Base hospital—Latrine and feces destructor	63
Base hospital—Incinerator	64
Base hospital—Electric-light plant	65
Base hospital—Typical barrack	66
Base hospital—Disinfector, new type	67
Base hospital—Miscellaneous details	68–69
Base hospital—Horsefall destructor	70
Base hospital—Electric wiring	71–83
Base hospital—Central administration	84
Base hospital—Central laboratory	85
Base hospital—Central garage	86–87
Base hospital—Central officers' club	88
Base hospital—Central nurses' club	89
Base hospital—Water lines	90
Base hospital—Sewers	91
Base hospital—Bill of material, 36-foot building	92
Plumbing material	92a
Base hospital—Feces destructor	93
Base hospital—Chapel	94
Hospital demountable barrack—Type C	95–99
Camp hospital—Layout	100

Plate.
Camp hospital—Ward............. 101
Camp hospital—Administration building......................... 102
Camp hospital—Patients' mess.... 103
Camp hospital—Bath and disinfector......................... 104
Camp hospital—Operating and clinic........................... 105
Camp hospital—Latrine.......... 106
Camp hospital—Feces destructor . 107
Camp hospital—Storeroom and mess............................ 108
Camp hospital—Personnel barrack. 109
Camp hospital—Latrine details... 110
Camp hospital—Feces destructor . 111
Camp hospital—Sewers........... 112
Camp hospital—Water mains..... 113
Camp hospital—Electric wiring. 114–117
Veterinary hospital and remount depot.......................... 118
Horse shelter................... 119–120
Horse dip........................ 121
Aeroplane assembly plant......... 122
Aeroplane depot.................. 123
Hangar, steel, 110 by 100 feet .. 124–127
Plate.
Hangar, steel, 66 by 100 feet..... 128–131
Montoir Dock................. 132–136
Terminal yards at Bassens Dock.. 137
General depot—Gievre............ 138
Engine terminal................. 139
Ashpit........................... 140
Inspection pit................... 141
Coaling facility.................. 142
Engine house..................... 143
Water tank....................... 144
Regulating station and advance depot........................... 145
Regulating station—Poincon-Les Larry........................... 146
Rail head—Sorcy.................. 147
Intermediate ammunition depot—Mehun......................... 148
Intermediate ammunition depot—Issoudun...................... 149
Advance ammunition depot....... 150
Bomb and grenade depot......... 151
General depot—Montierchaume. 152–153
Warehouse—Type B.............. 154
Warehouse—Type C.............. 155
Refrigerating plant............. 156–159

NUMBER 62
OCCASIONAL PAPERS
THE ENGINEER SCHOOL
UNITED STATES ARMY

MILITARY MINING

By

ALFRED H. BROOKS
Formerly Lieutenant Colonel of Engineers
U. S. Army
Chief Geologist of the American Expeditionary Forces

WASHINGTON
GOVERNMENT PRINTING OFFICE
1920

attack on Messines Ridge. The French rule is not to start an underground offensive if the opposing lines are more than 500 feet apart. It is said that the Germans had a regulation which makes it imperative to start a mine system if the enemy's lines are within 300 feet.

Successful mine attacks have been made by the British, by galleries that have been driven for a distance of over 800 feet, and there are many from 500 to 600 feet long. The average length of the attack galleries between lines is, however, less than 500 feet.

COUNTERMINING BY THE ENEMY.

In the first year of mine warfare, insufficient heed was given to the question of possible countermining by the enemy. It is now recognized that this is one of the most important elements to be considered. The first essential is to determine, so far as possible, the physical underground conditions on the enemy's side and thus to learn any difficulties with which he may have to contend. Actual mining operations can usually be detected by using several sources of information. The most important of these is the use of the listening instruments to be described below. Other sources are the location of spoil dumps, reports of prisoners, and the results of raids made into the enemy's trenches. Even if no direct evidence of countermining is obtained, the possibilities of an underground attack must always be prepared for, and every mine should be equipped with listening devices, and the guard, by systematic listening, never relaxed.

CHARACTER OF TERRAIN.

As already shown, the surface topography has an important influence on military mining. It will be determined whether the entry will be made by vertical shaft or horizontal gallery, and the surface profile, combined with the section of proposed mine, will indicate the amount of head cover and something of the drainage conditions.

UNDERGROUND CONDITIONS.

The influence of the geology on mine operations has been set forth at some length and it has been emphasized that the first preparation for mine warfare is a study of the geologic features. The general facts of the geology may often be obtained from published maps and reports, but field examinations will also have to be made and borings may be necessary.

AVAILABILITY OF MINING TROOPS.

In the British service all matters relating to mining are controlled by officers who specialize on the subject, and underground operations are entrusted only to the trained mining troops. Fatigue parties of line troops are, however, utilized for the transport of supply and matériel, as well as for other surface works. Experience has shown that no offensive mining project should be undertaken unless enough well trained technical troops are available to give reasonable assurance that operations may be continued under any situation that may arise. Underground warfare is a great strain on troops and frequent reliefs are necessary. Contermining by the enemy may cause destruction of galleries as well as casualties and demoralization among the personnel, and fresh mining troops should be held in reserve to meet such a situation.

The number of galleries planned for will give a measure of the technical troops required. In the British service, mining troops, under normal conditions, are supposed to work underground only one-fourth of the time; this, for the reason that the work is much harder than that which falls to the average soldier. In time of emergency, troops are, of course, kept underground much longer and a company has been known to be on duty for 36 hours. An experienced British mining officer informed me that under average conditions in rocks no harder than chalk it is safe to count on about 2 feet of heading per week for each miner in the company.

The relief for one heading usually consists of from 12 to 18 men distributed as follows: Three men at face, one man hauling from face to foot of incline, two men hoisting, one man on blower, and four men on the dump. In addition, other men may be needed for transporting of spoil and timber and to manipulate pumps. At average depth, two men using a small car on light rails can hoist the spoil up an incline from two headings driven in chalk at an average rate of 10 feet per day. The above facts give a rough measure of the number of men required for driving galleries. Sinking of shafts or inclines is slower, but there are so many variant factors that neither the probable rate of progress nor the number of men required can be expressed in definite figures. Then, too, the sinking of shafts is more likely to be seriously interrupted than the work in galleries. It is evident also that shelling may stop the advance of galleries by damaging the shaft or by the prevention of surface disposal of spoil.

AVAILABILITY OF TOOLS, MINE TIMBERS, ETC.

The choice of tools and other equipment will depend on the physical conditions as set forth above, which make it evident that different equipment will be needed for hard rock and for soft material. If power drills must be used, which has not been the case on the British front, more elaborate equipment will be necessary, including air compressors or electric motors. All galleries 60 feet or more in length will be artificially ventilated and therefore blowers, fans, or power-driven ventilators must be installed. Though it is seldom possible to carry on military mining below the depth of ground water, yet equipment for handling seepage water is usually necessary. Where the entrance is by shaft or incline hoisting equipment must be had, and this may be by block pulleys, by an improvised windlass, or by hand or electric hoist. The last, like other power equipment, has been little used by the British on account of the difficulties of installing and maintaining transmission lines. The amount of timber needed will depend on the physical conditions of the formations traversed. Estimates of quantities of explosives will be based on the plan of operations, depth of mine, and physical character of formation.

While ample provision of matériel must be made, an oversupply must be guarded against. An excess is not only a waste of equipment that may be needed elsewhere but also entails useless transportation, blocking the line of communication, as well as presenting difficult problems of storage at the front. The ideal to be aimed at is to have the timber delivered only as fast as needed. Though an excess of matériel must be guarded against, there must, during active underground warfare, always be enough to meet every emergency.

PLAN OF OPERATION.

No mining should be undertaken without a definite plan of operation formulated on the basis of as full information as possible regarding the physical conditions. Therefore, the first step will be to study the ground and, if none be available, to prepare a topographic map and also to make a geologic map and cross sections. This information being at hand and the general plan of underground attack including its coordination with other arms approved, the next step will be to lay out the system of mine works.

Obviously the plan of the mine will depend in part on the location of its entrances. Most often this location will be limited in the direction parallel to the front either by the tactical situation, or by the physical conditions. If underground attacks be possible along a wide front it will be advantageous to select a sector in which there has been no previous mining, for there the enemy will be least likely to be on guard. As a rule there is considerable latitude in the choice of place of entry along the depth of the position (right angle to the front). The siting of mine entry must be based on the weighing of the relative advantages of a forward and rear position. The farther to the rear of the mine entry the greater the length of the galleries, while the farther to the front, the greater its vulnerability to attack. Mine entrances made at the front-line trenches are not only most exposed to raids, gas and trench-mortar attacks, but produce greater interference between the defending infantry and the engineer troops than to those made farther back. For these reasons, entry is seldom made from the firing trench except in an emergency when every consideration except speed of underground advance is disregarded. Most often the entrances to mines are at or near the support trenches and 100 to 200 yards in the rear of the firing trench. Sometimes an emergency mine is started in the forward trench and as soon as possible connected by galleries with an entry farther to the rear.

Every advantage must be taken of natural and artificial cover. If it be possible to drive a gallery from the foot of escarpment this will greatly facilitate advance. From an engineering standpoint, quarry faces are equally valuable for mine entries, but have the disadvantage in that their location is usually well known to the enemy and they are likely to be subject to artillery fire. Mine entrances are sometimes made from shell or mine craters. This usually, however, serves only for a single gallery, as the craters do not afford favorable conditions for disposal of spoil.

The choice of position is influenced by the question of the proper disposal and camouflage of spoil. The disposal of the débris from the mine operations is indeed one of the most difficult problems in military mining. In the St. Mihiel sector the Germans located the entries to a tunnel within the walls of a partly demolished church. This so sheltered their operations, as well as their spoil, that the exact location of the tunnel was not determined, though its general position had been learned from reports of prisoners.

Mine attacks are usually made at the greatest depths which the physical conditions will permit. In general, the vertical zone of attack is limited at the top by the maximum depth of penetration by enemy's shells, say 10 to 30 feet, and at the bottom by the ground-water level. This rule has, however, exceptions. The tactical situation may demand an attack where physical conditions prevent sufficient depth for a safe overhead cover. In such case, steel I beams should be used for caps and all timbering made very heavy. The success of such shallow mining will, however, usually depend on its nondiscovery by the enemy rather than on actual protection of the galleries against artillery fire.

In absence of natural drainage and where the large power pumps can be used it may be practical to put the mine galleries below the ground-water level. In general, the best place for a mine system is at the ground-water level, which will give protection against countermines from below.

Most of the British mining was at depths of from 20 to 100 feet. They have made some attacks as deep as 200 feet. The great system of mines at Messines Ridge averaged nearly 100 feet in depth. In the Vosges, near St. Die, the French drove self-draining galleries in tough sandstone and conglomerate at depths of 200 feet.

It is evident that the choice between entries by shaft incline, or by gallery, will depend very largely on the surface terrain. The French, however, made much use of a gently sloping gallery, instead of a shaft. The relative advantages and disadvantages of the different types of entry will be discussed below. Every mine should have at least two entries spaced as far apart as conditions permit. This to provide for an emergency exit if one entry be destroyed by shell fire.

Having determined the location of the mine mouth the azimuth of the line connecting it with the objective must be determined, which can usually be done correctly from the map. This azimuth must subsequently be carried underground to serve as a guide in determining the direction of the galleries. Requisitions for details, mining troops, and fatigue parties of line troops, will, of course, be one of the necessary preliminaries, and this will include reserves which may be needed to meet any conditions that may arise. Requisitions will also be made for matériel, including tools, sandbags, mine timber, explosives, etc. Equipment to meet the local condition may require hoists, ventilating fans, mine cars, light rails, power machines, pumps, etc.

When the mine is opened up, a listening guard is established and the acoustical instruments provided. This will include the installation of the microphone with central listening station. A detail of soldiers trained in mine rescue work is also made and provided with necessary equipment. As soon as possible an underground first-aid station is excavated.

Surveys of the mine workings must be started at the beginning, and the results kept platted on a map. If the enemy be countermining, the location of any sound, as determined with the geophone, is platted on a mine map and a record made of the character of the sound. If the enemy be near at hand, preparations must be made for the rapid installation of mines or camouflets, including the estimates of the quantity of explosives needed to attain the desired results of destruction. If the mine to be exploded be a large one, special chamber or chambers may have to be excavated.

A mining project, once started, must be prosecuted with greatest vigor, so that the ground may be seized in advance of the enemy. Both sides will attempt to be the first to drive galleries at the maximum depth so as to have their opponent above, a decided tactical advantage. For the sake of flank protection, and so far as conditions permit, the ground should be fully occupied laterally. Flank protection is secured by the proper location of listening and defensive galleries. In rare instances the physical conditions may afford the necessary protection. Should the gallery be located at depths determined by the ground-water level, the enemy can not attack from below. In some instances there may be a change in the bedrock that affords protection by hindering or retarding countermining. Again, the upward slope of the ground-water table may protect a flank from attack by forcing the enemy so near the surface as to give him insufficient head cover.

The spacing of the defensive and listening galleries will depend on the physical condition of the ground. This spacing is based on the principle that it should be at such intervals as to prevent the enemy from penetrating between galleries without discovery. Also, that his countermines can be destroyed by explosives when so discovered. The physical conditions of the strata affect the transmission of sound, and also, together with the depth of the overhead cover, determines the radius of destruction of mine explosions.

If the formation is such that it can be easily excavated and with but little sound, it will be possible to make feint attacks combined with flank attacks. A feint may be made by driving a heading directly toward the enemy with an undue amount of noise, while at the same time a flank attack is in progress by another gallery. The latter is driven with as little noise as possible. Such tactics are seldom practical if the material to be excavated is chalk or harder rock, because it is not then possible to do the work quietly enough to deceive the enemy. If, however, the formation be clay, giving the most favorable conditions for underground attack, it is sometimes possible to penetrate the enemy's works before discovery. Under such conditions preparations are made for hand-to-hand underground fighting, such as has taken place many times on the British front. The British, however, discouraged such fighting, as it seldom leads to any decided tactical advantage. These skirmishes have, however, the merit of developing the morale of mining troops, and thereby intensifying their interest in the work in hand.

When the works of the enemy are penetrated the first duty is to cut the wires and remove the detonators of any mine found in place. This accomplished the explosive is removed. As a general rule, the enemy's gallery is then blown up as far back as circumstances permit. Under some conditions it may be best to try to hold the enemy's gallery instead of destroying it. This will call for the building of traverses or barricades with sandbags and the maintaining of a defensive guard. If time permits a survey of enemy's works should always be made.

Surprise attacks, such as the above, are the exception rather than the rule in the face of an alert enemy. In general, reliance is placed on rapidity of advance rather than on silence in operation. In hard rocks requiring drilling, the enemy can best be deceived by making an inordinate amount of noise in the operations. It has been stated that this sound of pneumatic drills is exceedingly difficult to locate accurately. Therefore, if the equipment be at hand the driving of several galleries in hard rock with the use of pneumatic drills may be a very effective mode of attack.

Various ruses for deceiving the enemy are also used. When the countermines are close at hand, mechanical devices operating from a distance which simulate the sound of a pick or shovel, may induce the enemy to explode a camouflet. The simulation of the charging and tamping a mine may also lead the enemy to make an attack. Mine explosions always wreck to a greater or less degree the enemy's own gallery, as well as his opponent's. It thus may interrupt the progress of his own mining, while his opponent advances from another direction.

Though the explosion of a camouflet reveals the proximity of the enemy, yet experience has shown that it gives little definite clue to the direction of the mine chamber. The survivors of such an attack usually make only hazy and conflicting statements regarding the direction of the shock, and as the gallery has been wrecked, no direct evidence is obtainable. The British made some experiments in the use of the seismograph for determining direction of mine explosions, but the results are reported to be negative. It appears that the earth waves induced by the explosion are more or less uniformly projected in virgin ground of unbroken strata and that their center of origin can be determined by the seismograph. The waves are, however, so greatly deflected by rock structures or by shell and mine craters, and their attending earth ruptures, the normal conditions at the front, as to make it impractical to determine the center of explosion by the use of the seismograph.

The explosion of a mine will reveal the position of the chamber by forming a crater. Hence, only camouflets are used for the destruction of countermines, and the changes are carefully gauged to bring about the desired results. If too much, it wastes the explosive, shatters a larger zone than necessary, and in extreme cases may form a surface crater. Excessive shattering of the bedrock is to be avoided unless deliberately done to impede the enemy, for it greatly increases the difficulties of subsequent mining. Charges may be placed in the end of attack or defensive galleries and tamped with sandbags, or may be placed in specially prepared chambers. (Figs. 9, 10, 19.)

Usually a mine will not be exploded until the objective of the attack has been reached, and all preparations for the advance by the infantry made. This grand attack may include the simultaneous explosion of many mines in separate chambers or galleries. At Messines Ridge, 19 mines were exploded at one time, charged with a total of about 1,000,000 pounds of ammonal.

It should be noted that simple mining operations are sometimes used for the sake of advancing the field works. These may be projected at shallow depths toward the enemy, and when the proper position has been reached an explosion of a mine will form a surface crater. This crater is then occupied by the infantry as soon as the fumes have been dissipated. These are generally local attacks and are not coordinate with a general system of underground warfare. Another use made by the British is as follows: A small gallery is driven at shallow depths from the front-line trench. Within this gallery is placed a boring machine (fig. 15) capable of excavating a hole to 6 inches in diameter. A horizontal hole is then drilled to within a short distance of the enemy's trench. When the time for the attack is at hand, the hole is extended through to the enemy's trench and a pipe charged with explosives inserted in it.[17] The explosion of this will open up a passageway through the barbed wire entanglement and into the enemy's trench. It has been found that sufficient explosives can be inserted in this way to lift 14 feet of soil and subsoil. This mode of attack obviously has no relation to underground warfare, though the operations are carried on by mining troops.

MINING SYSTEM.

The plan of a mine system will be based on the tactical situation, modified by the physical conditions already considered. Two general systems are used: (1) A series of independent galleries driven more or less directly toward the enemy, with branches for attack, flank protection, and listening. (See fig. 7.) This is called the "fishbone type." It is preferred by the French (see fig. 9) and generally used by the Germans (see fig. 10). (2) A lateral gallery parallel to the front line, from which parallel attack, defense, and listening galleries are projected toward the enemy. (Fig. 8.) This may be called the "lateral type" and was most used by the British. (See fig. 19.)

The fishbone type, long used in mine warfare, has the advantage in that the work is concentrated on an advance toward the enemy. French officers claim the additional advantage that each mine being independent there is less interference in the handling of spoil from different headings than in the case of the lateral type. Such criticisms do not appear to be justified, for the ease of transporting spoil from the heading to the surface will depend on the size of the galleries and number of entries. Moreover, the free system of intercommunication offered by the lateral type will facilitate rather than hamper underground traffic. A more serious criticism, also made by the French, of the lateral type is that all the works being communicating, the gases being developed by mine explosions will permeate the whole system. This, however, may be guarded against by gas-proof doors which will, however, hamper communication. Another objection made by the French is that if a countermine reaches the lateral

---

[17] The French use a boring machine for a similar purpose. See Mining Operations, Especially for Infantry, by Col. W. R. Livermore, U .S. Army. Professional Memoires, Corps of Engineers, U. S. Army, vol. 10, 1918, p. 130.

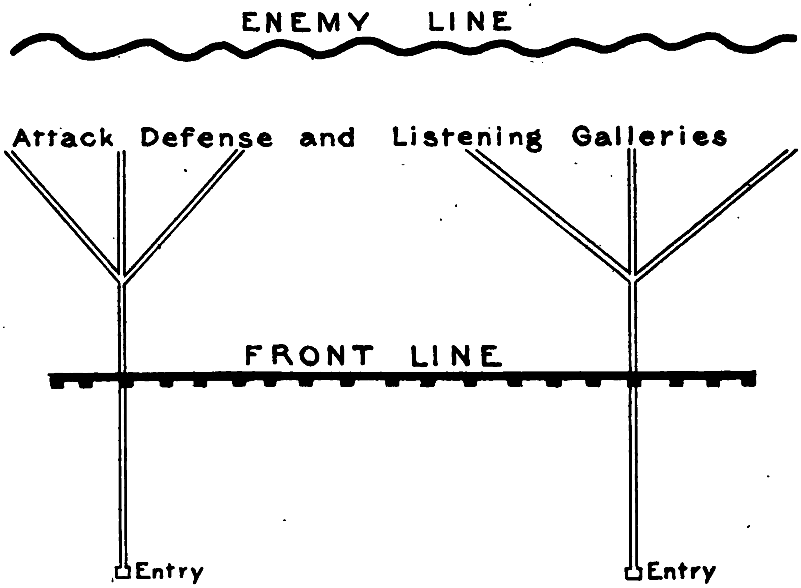


FIG. 7.—Diagram of fishbone mine system.

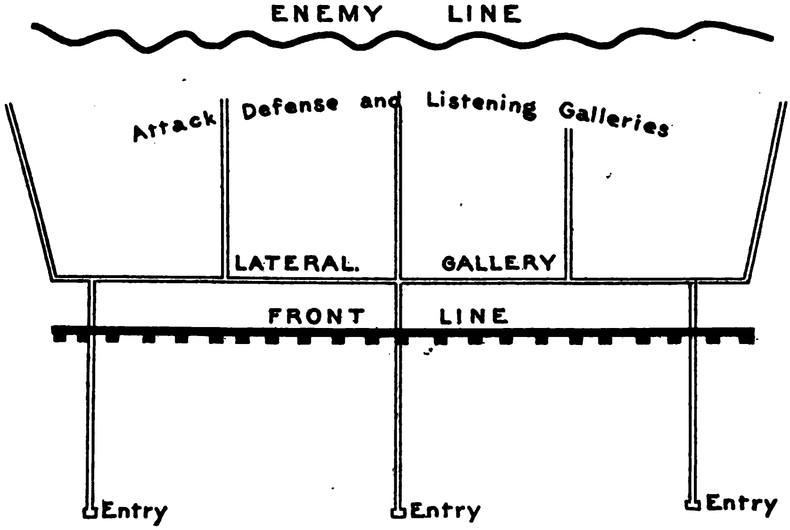


FIG. 8.—Diagram of lateral mine system.

gallery, the whole system may be interrupted by one explosion. This is provided for by keeping the lateral gallery far to the rear and not over 100 feet from the front-line trenches. If the enemy reaches that close he will expose himself to flank attacks.

Whatever may be the relative advantages and disadvantages in attack it seems certain that the lateral type first developed by the British is the best for defense. (Fig. 19.) This type makes it impossible for the enemy to reach his objective without penetrating the opponent's works. On the other hand, in the fishbone type there is always the chance that the enemy may penetrate between two galleries. (Figs. 9 and 10.) It is in general true, however, that in any extensive mining system, both types will be more or less used. (Fig. 9.)

Military mines with galleries at two levels have long been used in underground warfare. In many cases they have been the result of change of system enforced because of ignorance of the physical underground conditions rather than to a deliberate plan. One of the conditions that may lead to a two-leveled mine is the unexpected meeting with ground or artesian water, thus forcing the abandonment of the lower workings. The seasonal fluctuation in ground-water level may also force the mine to be continued at a higher level. An offensive mine system on two levels is sometimes made as a part of a deliberate plan. In this, the upper gallery may be a feint to deceive the enemy, while the actual attack is made at greater depth. This mode of attack (see fig. 11) has been considerably used by the French.

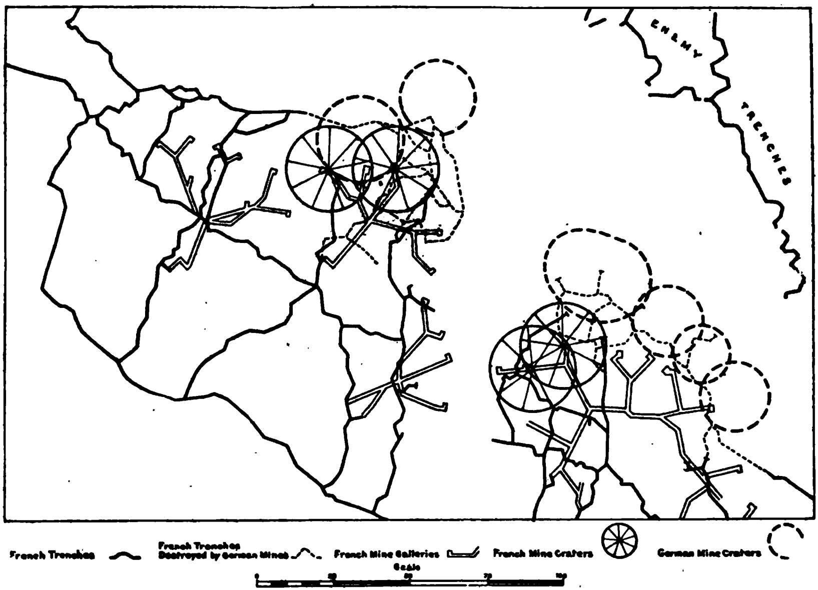


FIG. 9.—Plan of French mines, fishbone system, near Flirey, Lorraine.

DEFENSIVE MINING.

Most of the principles already presented relating to offensive mines apply with equal force to defensive mines. An adequate defensive mining system can only be established before the enemy has begun countermining. When

NUMBER 62

OCCASIONAL PAPERS

THE ENGINEER SCHOOL

UNITED STATES ARMY

MILITARY MINING

By

ALFRED H. BROOKS
Formerly Lieutenant Colonel of Engineers
U. S. Army
Chief Geologist of the American Expeditionary Forces

WASHINGTON
GOVERNMENT PRINTING OFFICE
1920

LIST OF ILLUSTRATIONS.

Page.

FIG. 1. Siege and mine attacks in eighteenth century 7
2. French hand rotary drill with extension 11
3. French hand rotary drill held by chain 11
4. Diagrammatic section of French and German mines near Flirey, Lorraine 13
5. Cross section in Woevre Lowland, Lorraine, showing underground condition and mine entrance 15
6. Cross section on British front, showing location of gallery between two water-bearing formations 16
7. Diagram of fishbone mine system 26
8. Diagram of lateral mine system 26
9. Plan of French mines, fishbone system, near Flirey, Lorraine 27
10. Plan of German mines, fishbone system, near Vauquois Hill, Argonne 28
11. Diagrammatic cross section of French mine attack on two levels 29
12. Plans of methods of defense of incline 30
13. Plan of dog leg in attack gallery 32
14. Electric rotary drill 35
15. French hand boring machine 36
16. French single-handed rotary drill 37
17. French double-handed rotary drill 37
18. Method of using geophone 39
19. Plan of subway and connecting lateral mine system 42

NUMBER 62

OCCASIONAL PAPERS

THE ENGINEER SCHOOL

UNITED STATES ARMY

MILITARY MINING

By

ALFRED H. BROOKS

Formerly Lieutenant Colonel of Engineers
U. S. Army
Chief Geologist of the American Expeditionary Forces

WASHINGTON
GOVERNMENT PRINTING OFFICE
1920

The difficulties of transporting and disposing of the spoil after it reaches the surface often seriously interfere with the progress of mining.

DISPOSING OF SPOIL.

The disposal of spoil under front-line conditions is one of the most difficult problems. A dump is so conspicuous that it is easy to recognize even from a poor aero photograph. This is especially true of chalk and other white material.

In making spoil dumps the usual camouflage practice of avoiding steep slopes and strong shadows is practiced. Dumps are camouflaged with various materials, but this is difficult where they are constantly being added to. Spoil is also disposed of by gradually filling up natural or artificial depressions. Craters are especially well adapted to this purpose and are sometimes made deliberately for such use. All flattening out of dumps and waste of spoil on the surface must, under front-line conditions, be done at night.

A method successfully used is to build a parapet of sandbags and fill in behind it with the spoil. In such cases the top of the dump is kept flat and gradually merged with the surface of the ground. Another expedient is to dig a large pit along the side of the trench; cover this with camouflage. In this the bags of spoil are stored during the day aud at night are wasted outside the trench. If the material be light colored, it is covered with soil from shallow ditches.

In some cases no attempt is made to camouflage the dumps, which are placed far enough from the shaft to make it reasonably certain that shell fire, attracted by the dump, will not hit the shaft. In such practice the dump must be at least 100 feet from the shaft, which grealy increases the labor of transportation.

TOOLS AND MACHINERY.

As mining is only possible at the extreme front where conditions for transport are at their worst, in general only light equipment can be used. Under normal front-line conditions no equipment should be called for of which the unit pieces are over 80 pounds and which can not be handled by two men in the ordinary communicating trench. The problem of equipment is rendered more difficult by the fact that in spite of the limitations in weight and bulk the front line is no place for the use of delicate machinery, and all equipment must be of a substantial character.

Most of the mining of the British front was done with light picks and short-handled shovels. These are the tools with which the troops proved most efficient because of their previous use of them in civil life. For the excavation of small galleries not large enough for these tools, special implements are provided that need not here be described.

As already noted, the spoil is put in sandbags at the face and transported to the shaft either on men's backs or on small mine cars which were run on wooden or iron tracks. Sandbags must be furnished in large quantities for they usually can not be used for rock transport more than five times.

The British made little use of power drills because of the noise their use involved and because the rocks in their sections were not hard enough to warrant the difficulties of installation and maintenance. On the other hand, in many parts of the French front, there were hard rocks with which rapid progress was not possible without power drills. The French[30] used both electric (see Fig. 14) and pneumatic drills. The latter were preferred because of the help given to ventilation. Many British officers hold that if power drills are necessary, military mining will usually be impractical on account of the distance at which the operation can be heard. The French, on the other hand, hold that if the enemy are near enough to hear the use of the pick they will know the locality of the mine, and then speed will be the controlling factor. Moreover they also claim that it is more difficult to locate the sounds of the pneumatic drills than that of picking. Actual experience has shown that mining and countermining has been carried on where both combatants used air drills. It must be confessed, however, that these operations, so far as known, have not lead to important tactical results.

---

[30] École de Mines, Supplement de Livre de l' Officier, Paris, 1917.

Where power drills are used, the compressor or electric-motor must be placed as close at hand as conditions permit. This is to avoid long pipe lines or transmission lines, likely to be broken by shell fire. The French have operated air compressors within 800 feet of the enemy's line. In other instances, compressed air has been transmitted for over 3,000 feet within the zone of shell fire. It is needless to state that all power stations within the front line zone were to be placed in dugouts or otherwise protected from shell fire.

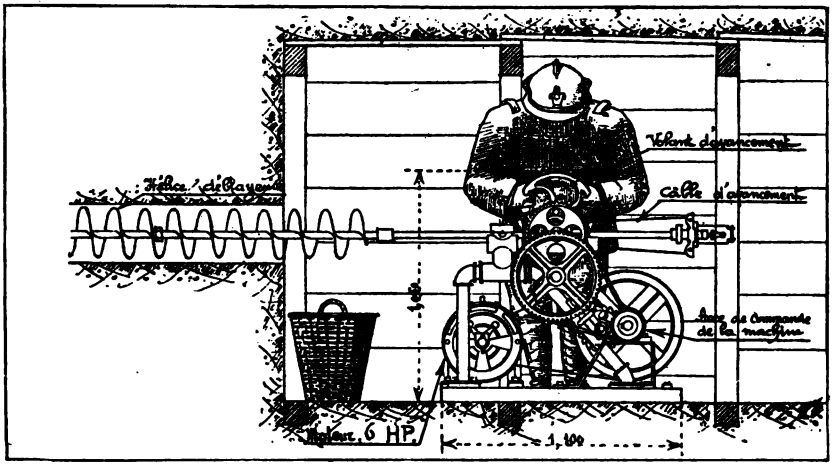


FIG. 14.—Electric rotary drill.

Both the French and British have made extensive use of hand drilling machines. The most important as employed by the British is the boring machine operated by three men, which will drill a 6-inch vertical or horizontal hole for a distance of 300 feet in chalk. It has, however, most generally been used for holes less than 100 feet in length. Its principal use, like that of a similar machine of the French, has been for ventilating holes in the roofs of dugouts and subways (Fig. 15). A special application of this machine in attacking enemy's trenches has already been described (page 39).

The British also had some light-weight power boring machines operated by two men, with which half inch to 1 inch holes could be sunk in chalk to a depth of 80 feet. These were very extensively employed by the British geologic officers to test underground conditions. Drilling parties commanded by geologic officers were kept in the field practically all the time, and in all over 1,500 holes were bored.

As but little British mining was done in rocks requiring blasting no drilling equipment for this work was used. On the other hand, the French made much use of hand machines for drilling holes for blasting. For this they used many of the standard types used in commercial work, and also had some specially designed for military purposes. The smaller of these were operated by one or two men. These machines and methods of operating are shown in Figs. 16 and 17. They included some for drilling large holes used for ventilating and for operating periscopes. (See Fig. 15.)

Both the French and British experimented with tunneling machines designed for driving small galleries. Some of these appeared to have merit for certain classes of material, but so far as known none were employed at the front. The French made considerable use of small belt conveyers in positions back of the front.

The information at hand, concerning types of equipment for pumping, ventilating, power, etc., is far from being complete and it will not, therefore, be desirable to attempt to list or describe the various machines used for this purpose. Suffice it to say that it was for the most part of the simplest type and much of it for hand operation. British pumping equipment varied from simple hand pumps to centrifugal pumps with a capacity of 1,000 to 4,000 gallons per hour, and with a lift of 30 to 150 feet. These latter were operated by 4-horsepower motors. The ventilating apparatus varied from the simplest hand blowers long used in civil life, to hand and power operated fans and to air compressors. The French equipment was of the same general character.

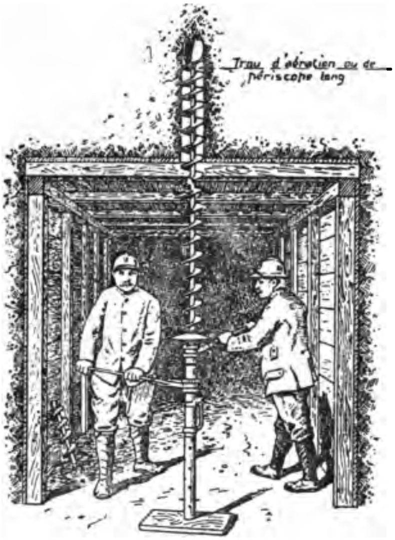


FIG. 15.—French hand boring machine.

The Germans are known to have made use of several types of boring machines. Lieut. Morley has described their use of boring machines as a defensive measure against underground attack.[n] In this case the position of the British galleries was unknown, but the enemy attempted to destroy them by discharging explosives in a series of bored holes (30 to 50 feet) made from the front-line trench. This haphazard defensive measure proved ineffective.

---

[n] Tunneling on the Western Front, by Lieut. George H. Morley, Canadian Mining Journal, Vol. XI, p. 343, 1919.

The Germans made no great use of mine machinery, employing chiefly hand tools, as did the British. In general, by needless timbering and other refinements the Germans were wasteful of labor. Their methods showed no evidence of lack of technically trained miners, as did those of the French.

All during the war the French were short of men to operate their coal mines. With their relatively small population, every man had to be put in the army who was physically capable of rendering service. Therefore, it was not possible to draw heavily on the civil mining population for technically trained men as did the British. No doubt if the conditions could have been foreseen which arose when mine warfare developed on a large scale a different policy would have been pursued. As it was, miners and other craftsmen were mobilized with their regular units and the losses in the early part of the war led to a great shortage of technically skilled men. The consequence of this was shown in the lack of experienced miners for dugout and mining work. This resulted in the French policy of making as much use as possible of labor-saving machinery.

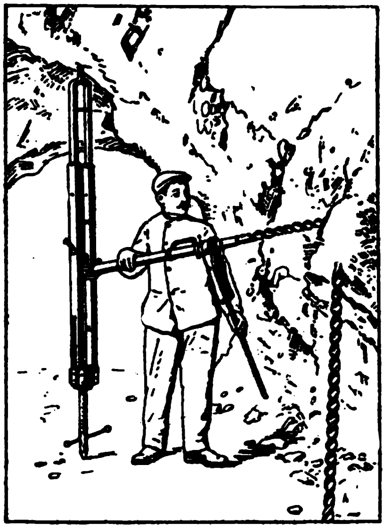


FIG. 16.—French single-handed rotary drill.

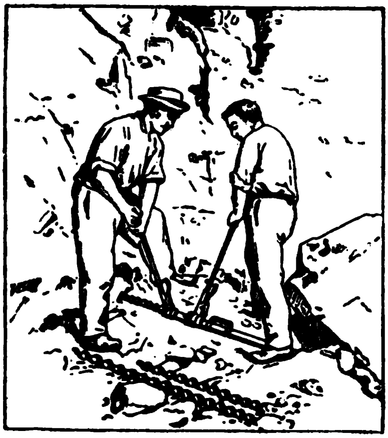


FIG. 17.—French double-handed rotary drill.

The British, who mobilized their armies later than the French, were able to profit by these mistakes, and had, moreover, a larger population to draw from. When underground mining developed on an extensive scale there were still many miners of military age in civil life. These were drawn into the tunneling companies to which were also transferred the miners who had been mobilized with the line troops. As a consequence the British had both more and better mining troops than the French. This is one reason why the British made less effort to economize on labor than did the French.

MINES AND CAMOUFLETS.

The destruction or capture of an enemy's position by underground warfare is made by the discharge of explosives. Surface works are attacked by mines, and underground works by camouflets.[22] The explosion of a mine always reveals the position of the chamber by forming a crater at the surface, while experience has shown that the discharge of a camouflet is very difficult to locate. As an explosion shatters the ground within certain radii of its center, it will destroy a part of the attacking works, as well as those of the opponent. This destruction of one's own galleries and the attending shattering of the ground, always difficult to drive through, are a serious handicap, and hence mines are not exploded without careful consideration of the consequences.

Charges from mines and camouflets are carefully gauged to bring about the desired radius of destruction and no more. If undercharged the destructive purpose of explosion is not accomplished; if overcharged it not only wastes the explosive, but the consequent shattering or even cratering of the ground will unnecessarily hamper further advance. The determination of the size of the charge is based on three factors: (1) Composition of explosive,[23] (2) character of formation, and (3) depth of mine.

The formulæ used by the Allies in calculating charges are the work of French military engineers. Using these formulæ, and the results of their own experience, the British prepared graphic tables by use of which the charges could be determined directly and without calculation. Such tables were prepared both for the chalk and the clay, these being the two formations occurring on the British front. The drawing of such graphic tables, for all formations likely to be met with, is an important part of the preparation for underground warfare.

The charges for mines and camouflets may be placed at the end of attack galleries and tamped by a series of walls and sandbags, but preferably in specially excavated chambers. (Figs. 9, 10, 19.) So far as possible, all mines are fired electrically. Usually in large mines two complete circuits are put in so that if one fails the other can be used. The size of the charges varies greatly, according to the work to be performed. Probably the largest single charge used by the Allies included 20 tons of ammonal.

MINE RESCUE.

As a result of the explosion of both friendly and enemy mines, the shattered underground works may be filled with gas and could not be safely entered except by men equipped with gas helmets, therefore, mine rescue apparatus forms an essential part of the equipment for underground warfare.[24] This equipment is chiefly of the standard type long used in commercial mining and need not here be described.

A mine rescue detail is made for every mining operation and as soon as the work has progressed far enough the first-aid station is established underground. In the British practice, a reserve station is put in farther back for about every two mines. When mining is active, the rescue detail for each station, according to the British rules, includes a noncommissioned officer and five soldiers. The stations are fully equipped with gas helmets, oxygen tanks, resuscitating

---

[22] A camouflet is a small mine whose charge is so gauged that the destructive effect does not reach the surface.

[23] Ball, Major, has described the explosives used by the British and Germans, opus cited, pp. 6–7.

[24] Mine Rescue Work, by Capt. H. D. Trounce, Engs. Professional Memoires, Corps of Engineers, U. S. Army, Vol. X, 1918, pp. 549–564.

The Difficulties and Dangers of Mine Rescue Work and Mining Operations Carried on by Men Wearing Rescue Apparatus, by Lieut. Col. G. David Logan, Trans. Inst. Min. Engs., Vol. LVII, pp. 122–197, London, August, 1919.

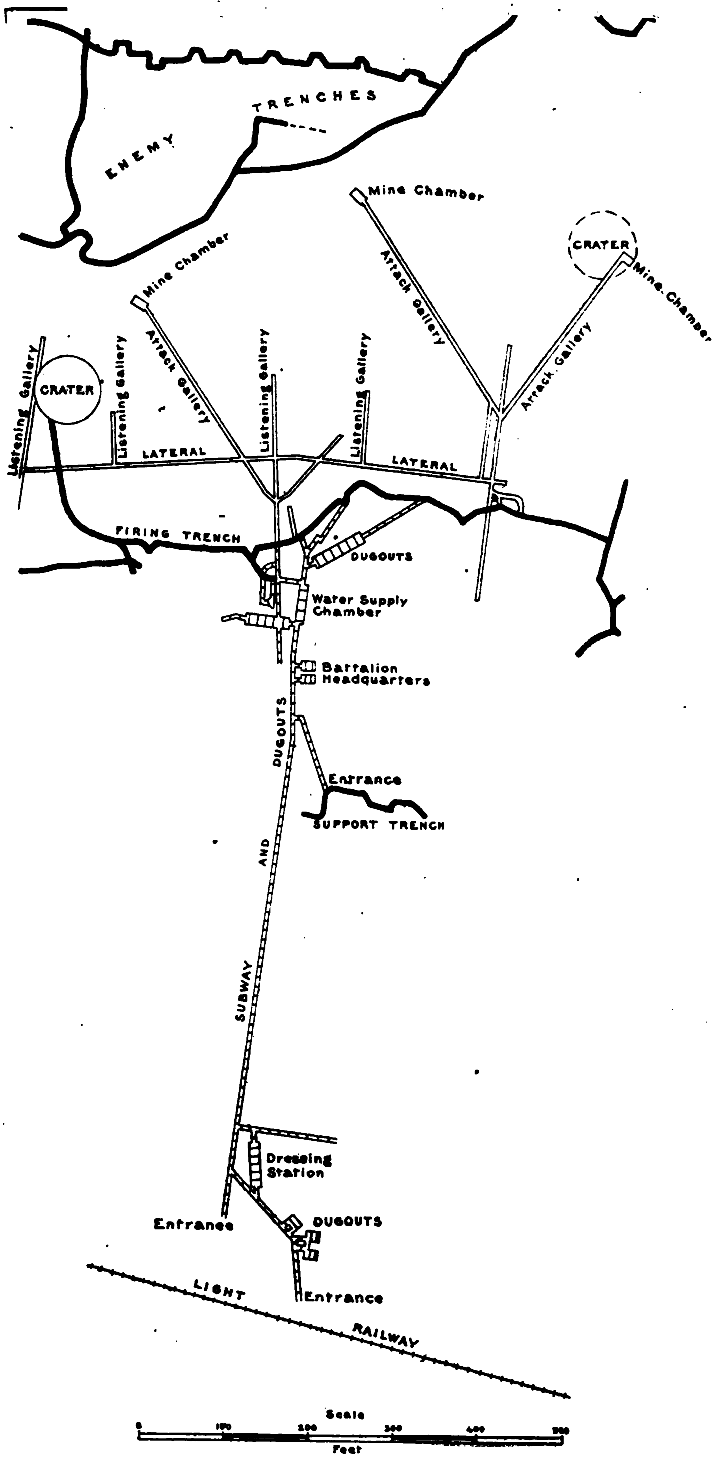


FIG. 19.—Plan of subway and connecting lateral mine system.

trenches was about 1,500 yards, but the total length of tunnel including branches over 3,600 yards. The branch galleries ended at inclines leading to strong points. Each was served by at least two inclines. Other inclines were provided, leading from the subway to trench mortar and machine gun emplacements. In this sector only the strong points were continuously occupied, the connecting firing trenches being guarded by patrols. No attempt was made to maintain communicating trenches which had been practically wiped out by shell fire.

This subway also afforded underground communication with an elaborate system of defensive mines extending beyond the front line trenches. Dugouts for infantry and mining troops, dressing stations, and chambers for housing dynamos were spaced at convenient intervals along the subway. It also served as a protected and convenient conduit for telephone wire and electric transmission lines. The subway was electrically lighted and supplied with water from pumped underground wells. Transportation of supplies and matériel was done through the subway by means of light mining cars. The rear of the subway was reached by a light surface railway which, being within the zone of shell fire, was used only at night. Needless to say that an elaborate defensive system, such as above described, means long preparation and in general is not properly a part of a field work.

The subways of the British were built by the mining troops and their construction and timbering is similar to that of the mine galleries. They have however, a larger cross section (6½ by 4 feet in the clear) and passing places where the width is increased to about 8 feet. The principles that have been presented on the excavation of mine galleries apply in general to subway construction. In the latter, however, on account of the distance from the front line, less heed need be given to arousing the suspicion of the enemy. For this reason, and because transportation is better, power-driven machinery can generally be used, the transmission lines being carried in under cover, the spoil dumps being further to the rear requiring less camouflage. Because of these conditions, the progress of subway construction is on the average faster than that of mine galleries. This is also owing to the fact that a subway can be excavated from more than one heading.

The numerous openings from a subway simplifies ventilation, which it is moreover always possible to obtain by bore holes to the surface. It is the British practice to place maps of the subway and its tributary dugouts and inclines on the walls at their entrances. Electrical signal bells connecting with the dugouts are placed at the mouths of the inclines leading to the front line trenches.

The defense of a subway is based chiefly on preventing the enemy from seizing its outlets into the forward trenches. Means of defending the inclines have already been described. Should the enemy penetrate the subway, dependence has usually been placed on temporary barricades built of sandbags. In some instances, loophole chambers have been excavated in the subways at the bends with a clear field of fire down the gallery toward the enemy. As an additional protection, a door is put in to block the passage of the subway at the side of the chamber.

◆